British museum guides.

1. Guide to the galleries of mammals(other than Ungulates)

2. Guide to the domesticated animals (other than horses)

3. Guide to the great game animals (Ungulata)

4. Guide to the specimens of the horse family (Equidae)

5. Guide to the elephants (recent and fossil)

6. Guide to the fossil mammals and birds.

7. Guide to the gallery of reptilia and amphibia.

8. Guide to the fossil reptiles, amphibians and fishes.

9. Guide to the gallery of fishes.

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AND 4 PLANS.

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GUIDE

TO THE

GALLERIES

OF

MAMMALS

(OTHER THAN UNGULATES)

IN THE

DEPARTMENT OF ZOOLOGY

OF THE

BRITISH MUSEUM (NATURAL HISTORY).

ILLUSTRATED BY 52 WOODCUTS AND 4 PLANS.

[*EIGHTH EDITION.*]

LONDON:
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1906.

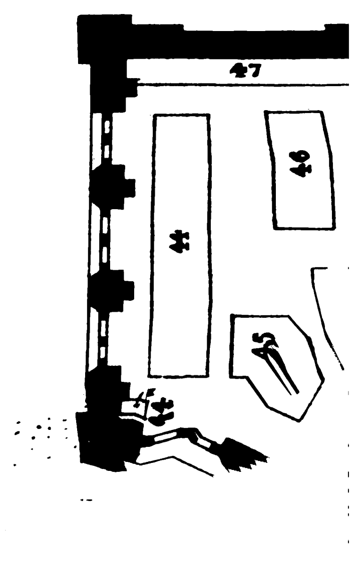
PREFACE.

THIS Guide has been prepared with the object of being of service not only to those who endeavour to learn something from a cursory view of the collections on a single visit to the Museum, but also to those who desire, by closer study, to acquaint themselves with the general arrangement and principal features of the members of the class of animals of which it treats. As the Great Game Mammals (Ungulata) form the subject of a special Guide, they are not included in the present work. As was the case with the 7th, the present edition has been revised and brought up to date by Mr. R. Lydekker.

E. RAY LANKESTER,
Director.

BRITISH MUSEUM (NATURAL HISTORY),
LONDON,
September 1906.


RUDOLPHI'S RORQUAL.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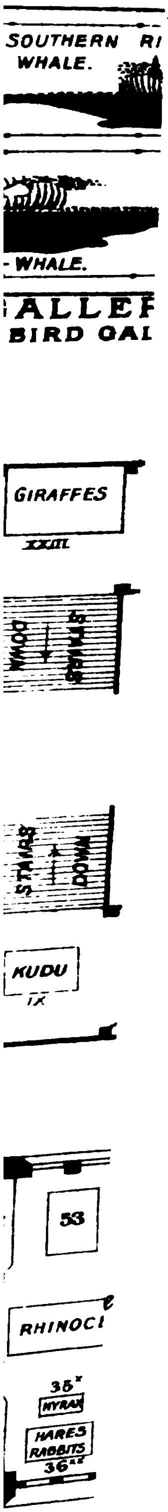

CONTENTS.

INTRODUCTORY.

MAMMALS are vertebrated * air-breathing warm-blooded animals, generally more or less clothed externally with hair, the females, being provided with mammary or milk-glands, also present, though small and functionless, in the males. With the exception of the Australasian Monotremes, which lay eggs, the young are brought forth alive. The limbs are usually four in number, the hind pair being, however, sometimes modified into swimming-paddles or suppressed altogether, while the front ones are in some cases developed into wings, and in others into flippers. The tail may be rudimentary, as in Man and the higher Apes; long and simple, as in Cats; prehensile †, as in the American Monkeys and Opossums; provided with a long tassel for driving away insects from the skin, as in Elephants, Cattle, &c.; or, finally, modified into a swimming-organ, either by the outgrowth of broad "flukes," as in Whales, or by its being flattened vertically as in Beavers, or from side to side as in the Musk-rat, the African *Potamogale*, and others.

The heart of Mammalia consists of two completely separated divisions, each with an upper and lower chamber (auricle and ventricle). The blood has a high temperature, except in some of the lowest forms, such as the Spiny-Anteater, or Echidna, of Australasia.

* *i. e.* with a backbone.

† *i. e.* with the power of curling round and grasping objects.

part of that formation in Ger...
are the early Jurassic or Middle ...
Stonesfield in Oxfordshire, where several
lower jaws have been discovered, such as th...
and *Phascolotherium*, figured in the "Guid...
and Birds." In Upper Jurassic times a...
Mammals must have lived in Britain, as...
found at Swanage. Jaws of allied Mam...
the Jurassic and Cretaceous strata of Nort...

At the commencement of the Tertiar...
Mammals were already abundant, many of...
types—a fact which shows how imperfect ...
intermediate time during which these cre...
gradually developed from their Mesozoic a...
the earliest of the Tertiary periods, has, for e...
of Bats, Insectivora, Carnivora, Rodentia, ...
Sea-Cows.

The Mammals of the Miocene, Pliocene, a...
for which the visitor is referred to the "Guide...
and Birds," have increased in number and va...
In many instances the extinct predece...
mammals were gigantic; but the Afri...
certain extinct members of the same ...
as any extinct terrestrial Mamm... group,
remains does not show that Wh... , and
larger than those which now sw... ...les have
... in our se...

The subjoined Table shows the manner in
are classified and arranged in the galler...
exhibition:—

Systematic Arrangement of the Existing Groups of the Class Mammalia.

Subclass I. **PLACENTALIA.**

MAMMAL GALLERIES.

In addition to the Elephants and Sea-Cows, which are shown in the Geological Department and the Central Hall, existing Mammals are exhibited in three galleries:—

1. The *Upper Mammal Gallery* (on the second floor), in which are placed the series of specimens illustrating the orders Primates, Chiroptera, and Insectivora. The cases are numbered in a continuous series, commencing on the left hand as the visitor enters, and ending with No. 16 on the opposite side of the door.

2. The *Lower Mammal Gallery* (on the first floor and the adjacent corridors), containing the representatives of all the other orders with the exception of the Whales, Sea-Cows, and the Elephants. The numbering of the cases forms a continuation of the series in the upper gallery, the first case on the left side of the entrance being No. 17; those in the corridors are separately numbered.

3. The *Whale Gallery* (on the ground-floor, leading out of the bird gallery), which contains models and skeletons of many species of Whales and Porpoises.

In order to understand the characteristic features of the various groups into which Mammals are divided, it is essential that the visitor should have some acquaintance with the names and relations of the bones forming the skeleton. To aid in this a

WHAL
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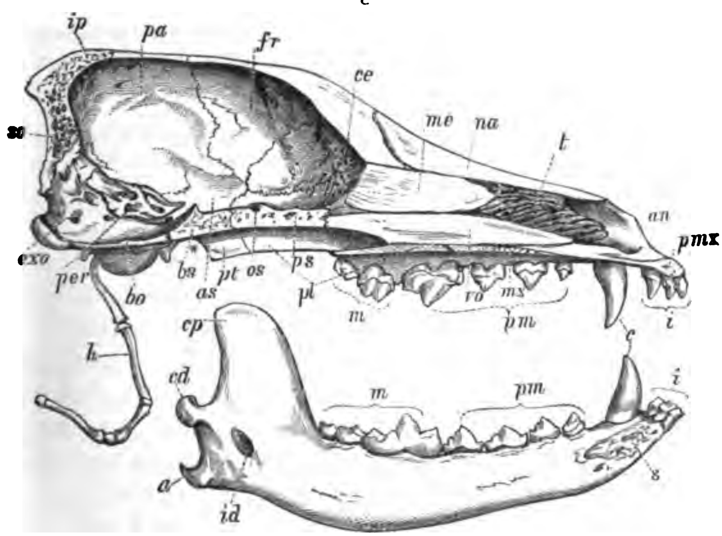
few notes and explanatory figures are given before coming to the proper subject of this guide.

The skeleton of a Mammal consists of two portions, one containing the bones belonging to the central axis of the body, viz. the skull, back-bone, ribs, and breast-bone; and a second portion, comprising those which form the limbs, and the girdles of bone by which the latter are attached to the back-bone.

Fig. 2.



The Skull of a Dog, divided down the middle line to show the internal structure.

an, nostril; *as*, alisphenoid; *bo*, basioccipital; *bs*, basisphenoid; *c*, canine teeth; *cd*, condyle; *ce*, cribriform plate; *cp*, coronoid process; *exo*, exoccipital; *fr*, frontal; *h*, hyoid; *i*, incisor teeth; *id*, inferior dental canal; *ip*, interparietal; *m*, molar teeth; *me*, mesethmoid; *mx*, maxilla; *na*, nasal; *os*, orbitosphenoid; *pa*, parietal; *per*, periotic; *pl*, palatine; *pm*, premolar teeth; *pmx*, premaxilla; *ps*, presphenoid; *pt*, pterygoid; *s*, union of two halves of lower jaw; *so*, supra-orbital; *t*, turbinal; *vo*, vomer; the asterisk indicates the part of the cranium to which the lower jaw is articulated. (*From Sir W. H. Flower.*)

The skull is the portion of the axial skeleton by far the most important to the systematic naturalist, who bases in great part his classification of Mammals on the variations presented by the

skull and teeth; the latter of which, although really no part of the internal skeleton, have, from their intimate relation with the skull, to be treated as though they belonged to that element.

The skull consists of three parts—(1) the brain-case, or *cranium*, a complicated framework of bones united to form a case for the brain, and a support and protection to the organs of smell, sight, hearing, and taste; (2) the lower jaw, or *mandible*; and (3) the *hyoid arch*, or tongue-bones.

The brain-case forms in its posterior half a large hollow chamber for the brain, and has in its base numerous perforations, or *foramina*, for the passage of nerves and blood-vessels. In front of this case, and separated by a sieve-like bone, the *cribriform plate* (fig. 2, *ce*), is a bony tube, open in front at the nostrils, or *anterior nares* (*an*), filled with light spongy bones, the *turbinal bones* (*t*), and forming the nose-chamber. Below this chamber and forming in part its floor and walls, is the upper jaw, composed of the *maxillary* and *premaxillary* bones (*mx* and *pmx*), in which are implanted the upper teeth, the lower ones being similarly fixed along the upper edge of the lower jaw. In an upper view of the skull the component parts of its roof are seen as paired bones placed one in front of the other along the middle line. Of these the hindmost are the *parietals* (*pa*), preceded by the *frontals* (*fr*), and by the small and narrow *nasal bones* (*na*), placed between the upper edges of the maxillary bones where they rise to form the side-walls of the nasal chamber. External to these bones are the *cheek*, or *zygomatic arches* (fig. 1, *zy*), which serve to support and protect the biting muscles, and are more or less developed in direct proportion to the biting-power of their owners. The hindmost part of the skull is made up of the *supraoccipital* (*so*), a pair of *exoccipitals* (*exo*), and the *basioccipital* (*bo*), surrounding the large opening through which the spinal cord passes—the *foramen magnum*.

The lower jaw consists simply of a pair of solid bones, joined together in front where they form the chin, but widely separate behind; each having a high projecting branch, the *coronoid process* (*cp*), for the attachment of the jaw-muscles, and an articular process, the *condyle* (*cd*), which forms part of the hinge on which the jaw works. This hinge is generally transverse to the general

axis of the skull; but in some orders, such as the Rodentia, the condyle is lengthened from front to back, and works in a corresponding longitudinal depression in the base of the cranium.

The tongue-bones, or hyoid apparatus (*h*), consist of a series of small bones suspended from the posterior part of the cranium, and supporting the larynx and root of the tongue.

The dentition of Mammals is of two kinds. In some few groups all the teeth are of one type or pattern, as in the Sloths, Armadillos, Dolphins, &c.; but the great majority are provided with teeth of several different types. Thus in the Dog's skull (fig. 2) the three small teeth fixed on each side in the premaxilla (*pmx*) are the incisors, or cutting-teeth (*i*); next follows a long and powerful tooth, known as the canine (*c*). Behind this there are four cutting-edged premolars (*pm*), and two flattened true molars (*m*). In the lower jaw the same types of teeth are represented, there being in the Dog three incisors, one canine, four premolars, and three molars. These numbers vary greatly in the different orders of Mammals, and for convenience of description the "dental formula" has been invented as a means of representing the number of each sort of tooth present in any animal. That of the Dog would be—I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{2}{3} \times 2 = 42$, the letters indicating the sort, and the numerals the number of the teeth present on each side of the upper and lower jaws.

A second dental division of the Mammals is founded on the fact that in a few groups there is only a single set of teeth, whilst in others the adult dentition is preceded by an earlier set, named the "milk" dentition, on account of its generally being present during the period in which the young animal is nourished by the milk of its mother, although its duration does not coincide with that of the latter, the milk-teeth being in some cases shed or absorbed by the time the animal is born. Dolphins, Sloths, and some Armadillos are examples of animals with only a single set of teeth during their lives; while the great majority of Mammals, like Man, have two fully-developed sets, viz. the milk- and the permanent dentition, the latter succeeding the former in a vertical direction.

The back-bone, or vertebral column, consists of a variable number of ring-shaped bones placed end to end, so as to form a long tube for

the reception of the spinal cord. The vertebræ are divided into five groups (fig. 1), viz.:—the *cervical* (*cv*), or those of the neck, almost invariably seven in number; the *dorsal* (*d*), those of the back, to which the ribs are attached; the *lumbar* (*l*), or loin-vertebræ; the *sacral* (*s*), or those to which the hip-bones are fixed; and the *caudal* (*cd*), or those of the tail, ranging from 3 (in some Bats) to 47 (in the Insectivore *Microgale longicaudata*, the longest-tailed Mammal known).

The ribs are curved rods of bone, from 9 to 24 pairs in number, attached to the sides of the dorsal vertebræ, and passing round the body; the greater part of them join the breast-bone or *sternum*, in front, while the remainder, known as the floating or false ribs, have their ends free.

Passing to the limb-skeleton, we have to notice first the shoulder-girdle, which in Mammals consists generally of only two separate bones—the *clavicle* or collar-bone, very often absent or imperfectly developed; and the *scapula* (*sc*) or shoulder-blade, to which latter there is firmly united a small projection of bone, the *coracoid* (*cr*), representing a third girdle-bone, completely separate in Birds, Reptiles, and Fishes, and also in the Monotremes, or lowest Mammals.

The *scapula* is a more or less flattened triangular bone placed outside the ribs, but not attached to them by bone, and with its narrow end directed towards the ventral side of the body. At this narrow end there is a hollow socket into which the head of the upper arm-bone fits. Down the centre of the scapula on its outer surface runs a long prominent ridge, terminating below in a prolonged process (*acromion*), to the tip of which the collar-bone, when present, is attached; its other end being united to the upper part of the breast-bone.

The *humerus* (*h*), or upper arm-bone, is the powerful bone placed between the shoulder and elbow, and articulating above with the scapula by a ball-and-socket joint and below with the *radius* (*r*) and *ulna* (*u*), the bones of the fore-arm, by a simple hinge-joint allowing motion in one direction only.

The two bones of the fore-arm are joined below to the wrist-bones, collectively called the *carpus* (*cp*), and succeeded first by the *metacarpals* (*mc*), or palm-bones, and then by the *phalanges*

(*ph*), or finger-bones, usually three to each properly developed finger.

The posterior girdle or *pelvis* (*pv*) is comparatively strong and rigid, firmly attached to the sacral part of the back-bone. Originally it consists of three distinct bones on each side—the *ilium* (*il*), *ischium* (*isch*), and *pubis* (*pb*), corresponding, the first to the scapula, and the two latter together to the coracoid; but soon they are so completely united as to appear but a single bone.

The hind-limbs themselves consist of a similar set of bones to those of the anterior pair, viz. the *femur* (*fm*), or thigh-bone, corresponding to the humerus, followed by the *tibia* (*tb*) and *fibula* (*fb*), or shin-bones, representing the radius and ulna; the *tarsus* (*ts*), or ankle-bones, corresponding to the carpus, and the *metatarsals* (*m*) and toe-bones (*ph*) to the metacarpals and finger-bones.

The digits never exceed five in number on each limb, and are often less numerous, being in some cases, as in the Horse, even reduced to one.

Order I. PRIMATES.

(Upper Gallery, Cases 1–14.)

The Primates consist of Man, Monkeys, and Lemurs. The Monkeys most nearly allied to Man are the so-called Man-like Apes (the Gorilla, Chimpanzee, Orang-utan, and Gibbons), which in many points of their internal structure approach more nearly to Man than to the other Monkeys, though their resemblance to him, both in osteological and external characters, is far greater in their infancy than after they have attained maturity.

The Primates, in their osteological characters, are distinguished from other Mammals by having the orbit completely surrounded by a bony plate, by always having clavicles or collar-bones, by the presence, with but few exceptions, of five digits on each extremity; the thumb being sometimes, and the great toe almost always freely opposable to the other digits, and very largely developed. There are never more than two incisors on each side of each jaw, and canines are almost invariably present. Man, Apes, and Monkeys constitute the suborder Anthropoidea.

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their ... length by the hind
pair; by their lower central incisors being larger than the outer ones, the converse holding in Man and the Man-like Apes; by their more numerous back-vertebræ; and by many other less definit characters which remove them further from Man towards the lowe Mammals.

All the Old-World Monkeys and Man have an osteo character in common, viz. the presence of a long bon leading from the outer to the inner ear, which ... tu ... entire absent in the New-World Monkeys. Their dental ormula invariably I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{2}{2}$, M. $\frac{3}{3} \times 2 = 32$.

Fig. 11.

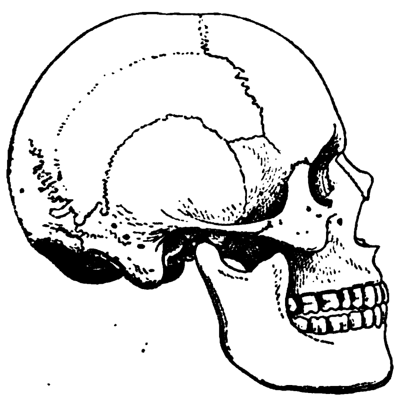
Heads of the Proboscis Monkey, *Nasalis larvatus* (A), and the Orange Snub-nosed Monkey, *Rhinopithecus roxellanæ*

In this family are included the Langurs, *Semnopithecus* (? 22), which are monkeys of medium size, with long tails, smal callosities, and generally *rather* short crisp fur, nearly colour, natives of India, China, and the East-Indiar A more striking species, both in form and colour, Monkey, so called on account of the remarkabl *Nasalis larvatus*, of Borneo, of which exa (23), fig. 11, A. Near by is the *Rhinopithecus roxellanæ* (2

with the axis of the vertebral column, instead of at right angles to it, as in other Mammals; the thumb is so attached to the wrist-bones as to be completely opposable to the other four digits, while the great toe is fixed parallel to the other toes, so that the foot is quite flat beneath, with little power of grasping, but forming a base on which the body may be balanced. The tail is only represented by the *coccyx*, an immovable bone composed of from three to five united vertebræ.

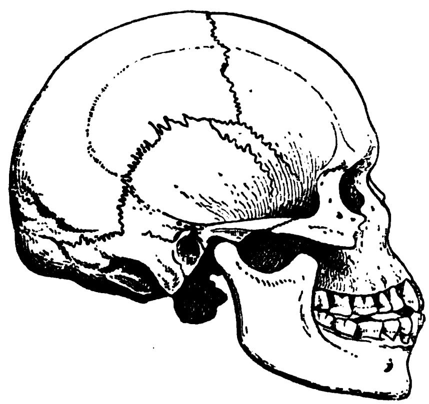
Man's skull differs from that of the other Mammals in the great size of the brain-case, and the proportional reduction of the bones of the face, the result of the high development of the brain and the disuse of the jaws and teeth as weapons of offence and defence. It therefore follows that those races of mankind which have prominent jaws and small brain-cases are of a lower type than those in which the jaws are more reduced in size and the brain-case is larger. Thus the Australians and Tasmanians have a very

Fig. 6.



Skull of a Caucasian.

Fig. 7.



Skull of a Tasmanian.

small brain-cavity, thick skull-bones, receding forehead, overhanging brows, flat nasal bones, long and low orbits, very broad and low nasal-opening, forwardly projecting jaws but receding chin, and large teeth: strongly contrasting in each of these respects with the skull of a European.

however, are never prehensile. They are distinguished from the *Simiidæ* by the quadrupedal position of the body, and the consequent modification of their skeleton, especially the shortening o[f] their fore-limbs, which are always exceeded in length by the hin[d] pair; by their lower central incisors being larger than the outer ones, the converse holding in Man and the Man-like Apes; by thei[r] more numerous back-vertebræ; and by many other less definit[e] characters which remove them further from Man towards the low[er] Mammals.

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size by the removal of the skull, and exhibited to display the character of the hair. To this same division are here assigned the Polynesians, and the Maories of New Zealand, of which latter a tattooed head is exhibited. Two skeletons of Arawak Indians from Guiana are of great interest to the anthropologist.

The three remaining cases on the left side of the upper gallery are devoted to the Negro or Black Races, including not only the typical negroes of the African Continents, but also the Negritos of the Andaman Islands, and the Melanesian inhabitants of Eastern Polynesia and Papua, together with the Australians and Tasmanians. Of the latter, now extinct, busts of two of the last survivors of the race, as well as a skeleton, are exhibited; and it will be seen that these people differ from the Australians (represented in the opposite case by models) in the frizzly nature of their hair, whereby they resemble the true negroes. The South-African Bushmen—also a very low type—are represented by the busts of a male and female; and the African Pigmies are exhibited in the form of the skeleton of a female of the Akka tribe obtained in Equatorial Africa by the late Dr. Emin Pasha, and by one of a male of the Bambuti tribe given by Sir H. H. Johnston. The Papuans are illustrated by photographs as well as by models and skulls; in addition to skulls, the fast-disappearing natives of the Andaman Islands are represented by three skeletons. [Cases 5–7.]

Case 7*, at the west end of the gallery, displays some of the most important structural differences between Man and Apes; and likewise the different types of human skulls, and the mode of measuring the same, with their respective brain-capacities. [Case 7*.]

In this case, too, is placed the only known fragment of the skull of *Pithecanthropus erectus*, a creature from the superficial deposits of Java supposed to connect Man with the Man-like Apes, and more especially the Gibbons. On the adjacent screen are exhibited the "papillary ridges" on the hands and feet of Man and Apes, and also the method of identifying criminals by means of finger-prints.

The *Simiidæ*, or Man-like Apes (case 8), are characterized by their inclined spinal column, broad breast-bone, the great length of their arms as compared with their legs, the enormous

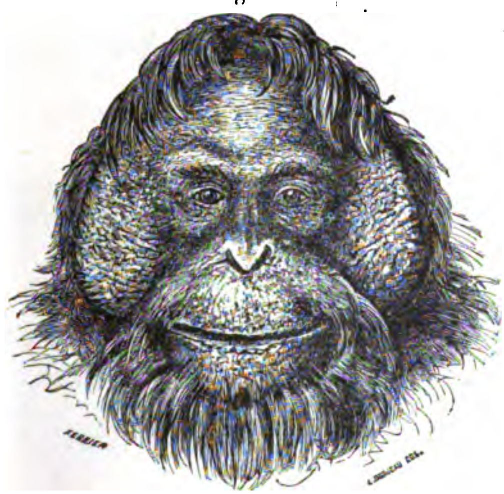
limbs—of which, alone among the family, the anterior are long… than the posterior—their rudimentary thumbs, and long prehensile tails. The Howling Monkeys, *Alouatta* (Nos. 120–131), the males of which possess a most extraordinary voice, whose resonance is increased by a peculiar chamber formed by the middle portion of the bone of the tongue: they are stout, thick-set animals, with well-developed thumbs, prehensile tails, and generally of … uniform red, brown, or blackish colour, the males being furnis… with short thick beards. The Woolly Monkeys, Lago… (Nos. 114 & 115). The Sakis and Uakaris (*Pithecia*, Nos. 1… and *Ouacaria*, Nos. 134 and 135), two closely allied ge… first with peculiarly long thick hair all over the bod… the latter, though long, not being prehensile. Th… distinguished from all the other American Monk… scarcely any tail; one species (*O. calva*, 135) ex… bald, and all are very thinly haired, in marke… Sakis. The Douroucoulis and Squirrel-Mon… (Nos. 152–154), *Callithrix* or *Callicebus* (… *Chrysothrix* (Nos. 143–145), are all beauti… soft bright-coloured fur, long, hairy, non-… developed thumbs; they live partly on … Capuchin Monkeys, Cebus (Nos. 1… numerous dull-coloured species, with… developed thumbs. Being comp… trained specimens are frequentl…

[Case 12 E.] The last family of the m… (Nos. 156–168), or Marmose… non-opposable thumb, wh… nail, the rudimentary g… tail, and the different… animals, some not e… appearance, many… their ears, and… almost entirely… a single s… know…

ages are exhibited in the front of the large centre case near the entrance to the gallery; conspicuous among them being two male specimens, whose projecting jaws, powerful teeth, and enormous brow-ridges give them a ferocious and savage appearance, wholly unlike that even of the lowest races of men, or of their own young.

On the left of the same case are the Chimpanzees, *Anthropopithecus troglodytes* (**2**), and Orang-utan, *Simia satyrus* (**3**), the former being closely allied and somewhat similar to the Gorilla, and also natives of the forests of Western and Central Africa. The large male Orang in this case shows the peculiar shape of the cheeks,

Fig. 10.



Head of an adult Orang-utan *Simia satyrus*)

which are provided with thick wart-like protuberances. The Gibbons, *Hylobates* (Nos. **4–10**), far less man-like in every way, and perhaps representing a distinct family, are also exhibited in case 8. Their remarkable variability in colour, as exemplified by the groups of *H. pileatus* (**9**) and the Siamang, *H. syndactylus* (**10**), should be specially noticed. The Orangs and Gibbons are found in Sumatra and Borneo, the latter extending also northwards to Burma, Assam, and the Island of Hainan.

The *Cercopithecidæ*, comprising the rest of the Old-World Monkeys, are of very various sizes and proportions, some having no tails at all, while others have enormously long ones, which, [Cases 9, 9*& 9**.]

[Case .

... very variable in their color-
... being marked with various shades of red, brown, and black. Numerous specimens of the Ruffed Lemur, *Lemur varius* (**200**), are exhibited in the case, which also contains the Ring-tailed Lemur, *L. catta* (**199**).

The third sub-family is represented by the aforesaid Aye-aye (**229**, fig. 12), a creature with only 18 teeth, large ears, a long bushy tail, and long compressed claws on all the fingers and toes with the exception of the great toe, which is opposable and has flat nail. The middle finger of the fore-foot is unusually th
and it is said that with this finger the Aye-aye pulls out of th

Fig. 12.

The Aye-aye (*Chiromys m*

holes the wood-boring caterpill
It also uses its powerful inciso
like those of a Rodent, to
and other similar plants

The second family
or *Galagininæ*, d
tarsal bones.
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th

brilliant coloration and small upturned nose; it inhabits N.E. [Cases China. The Guerezas, *Colobus* (Nos. **25** to **34**), are closely allied to 8 & 9.] the Langurs, but natives of Africa; some are dull rufous or grey, and others finely marked with sharply contrasting black and white, with long tufted tails, notably the true Guereza (*Colobus guereza*), Abyssinia, which has on each side a peculiar fringe of long white hairs reaching quite down to the ground. A number of specimens of these black and black-and-white Guerezas are placed in case 9*, to exhibit the transition from the wholly black *C. satanas* (**28**) to species like *C. sharpei* (**27**), *C. caudatus* (**26**) and *C. vellerosus* (**29**), with much white. The long-tailed African Guenons, *Cercopithecus* (Nos. **35** to **57**), provided with cheek-pouches in [Case 8.] which food can be temporarily stored, have large posterior callosities, and extremely long tails; many of them are brilliantly coloured, as for example the Mona Guenon, *C. mona* (**52**). The Macaques, *Macacus* (Nos. **61** to **74**), are chiefly inhabitants of Southern Asia, but one species, *Macacus innuus* (**72**), occurs in North Africa and also leads a precarious existence on the Rock of Gibraltar. The Baboons, *Papio* (Nos. **79** [Case 9*.] to **90**), hideous animals with powerful teeth, projecting jaws, nearly equal fore and hind limbs, and dull-coloured fur, are natives of Africa and Arabia (case 9**). One species, the Mandrill, *Papio maimon* (**87**), of West Africa, has a short stumpy tail and a perfectly naked face, the skin of which is brightly marked with blue and vermilion. The Drill, *P. leucophæus* (**88**), is an allied western species, without the bright colours. All the others are dull-coloured animals, with well-developed tails, the South African Chacma, *P. porcarius* (**90**), and the eastern *P. anubis* (**80**) being well-known species. In the Arabian *P. hamadryas* (**86**) there is a large mantle of long hair on the shoulders. This is also developed in the Abyssinian Gelada, *Theropithecus gelada* (**78**), which is closely allied.

The American Monkeys, forming the family *Cebidæ*, have for [Cases their dental formula, I. $\frac{2}{2}$, C. $\frac{1}{1}$, P. $\frac{3}{3}$, M. $\frac{3}{3} \times 2 = 36$, thus differing 10–12.] from the Old World Monkeys by the presence of an additional premolar on both sides of each jaw. Externally they are characterized by their widely separated nostrils, frequently prehensile tails, less perfectly opposable thumbs, &c.

The family *Cebidæ* comprises:—The Spider-Monkeys, *Ateles* (Nos. **96** to **110**), remarkable for their extremely long and slender

(a continuation of the skin of the body) is expanded, being attached behind to the front of the hind-leg. In most species there is also an additional membrane spread between the hind-legs, in which the tail is included. The thumb alone is free and assists in locomotion during the awkward attempts of most Bats to walk on all-fours. The hind-limbs, which in ordinary Mammals propel the body forwards, are almost entirely relieved of that office, being singularly weak and feeble, and of little use to the animal except while asleep or resting, when it hooks the sharp claws, with which the hind-toes are furnished, on to some support, and remains suspended with the head downwards until again ready to fly.

In the skeleton (fig. 13) the fore-arm is formed almost entirely of the *radius* (*r*), the *ulna* (*u*) being rudimentary. The thumb [illegible] short, free from the flying-membrane, and provided with [illegible] (*ph*); while the other fingers are long, slender, and clawl[illegible] the exception of the index, corresponding to our fore-fing[illegible] in some genera also possesses a claw. Collar-bones (*cl*) are well developed in all the species.

The hind-limbs, which, as already stated, are t[illegible] differ from those of other Mammals in that t[illegible] backwards, so that the knee, like the elbow, is [illegible] Those species which are provided with a flying [illegible] the hind-legs have it supported by a long pr[illegible] to the heel.

The Chiroptera are divided into two s[illegible] orders—the [illegible] and Insect-eating Bats. The membe[illegible] of the first [illegible] which are confined to the Old W[illegible] d, are, as a rule, [illegible] size, with flattened back-teeth, s[illegible] ed for munching [illegible] with claws both on the first [illegible] d second fingers [illegible] latter are of smaller size, with [illegible] sharp-pointed bac[illegible] for crushing insects, and with [illegible] laws on the th[illegible]

[Case 16.] Of the Fruit-eating Bats [illegible] *Megachiropt*[illegible] *Pteropodidæ*) exhibited in [illegible] wall-case [illegible] mention are the large bri[illegible] ntly-colou[illegible] Flying-Foxes, of which [illegible] certain [illegible] Fruit-Bat, *Pteropus* [illegible] *ubatus* [illegible] spread of wing. On[illegible]

The second suborder of the Primates—the LEMUROIDEA—includes a number of Mammals of a lower type than those hitherto mentioned, and for the most part natives of Madagascar, although a few are found in Africa and Southern Asia. They are almost invariably arboreal in their habits, with generally long, bushy, and non-prehensile tails, opposable thumbs and great toes, large eyes, and long fox-like faces. From the Monkeys they differ osteologically by their longer snouts, smaller brain-cases, different dentition, and by the fact that the sockets of the eyes, with one exception, are bounded on the outside only by a simple rod of bone instead of by a distinct bony wall. Skeletons of all the principal genera are exhibited, and attention may be drawn particularly to that of *Tarsius spectrum* (**220**); remarkable for the extraordinary prolongation of the hind-foot. In this genus, as in the Monkeys, the sockets of the eyes are bounded all round by a thin plate of bone; and the dentition is I. $\frac{2}{1}$, C. $\frac{1}{1}$, P. $\frac{3}{3}$, M. $\frac{3}{3} \times 2 = 34$. In the Aye-aye, *Chiromys madagascariensis* (**229**), the teeth are extremely reduced in number, the formula being I. $\frac{1}{1}$, C. $\frac{0}{0}$, P. $\frac{1}{0}$, M. $\frac{3}{3} \times 2 = 18$. The incisors are very thick, long, and curved, and are without roots, as in Rodents. The crowns of its molars are flat and smooth. The suborder is divided into families, of which the *Lemuridæ* contains by far the great majority of the species, and all those inhabiting Madagascar which agree in the structure of the internal ear. It is subdivided into the following groups:— [Cases 13 & 14.]

The *Indrisinæ* or Sifakas, *Indris* (**171**) and *Propithecus* (**174–184**), characterized by their disproportionately long hind-limbs, the toes of which are united by skin, and the possession of only 30 teeth. They are exhibited in case 13, and are singularly variable in colour, as may be seen by the mounted groups of the different species. When on the ground they move in an upright position, holding their arms over their heads in order to balance themselves, and progressing by short leaps in a most awkward and ludicrous manner. [Case 13.]

The true Lemurs, or *Lemurinæ*, have fore- and hind-limbs of nearly equal length, toes free to the base, and 36 teeth. They are more quadrupedal in their actions than the last [Case 14.]

(a continuation of the skin of the ... behind to the front of the hind-leg. ... also an additional membrane spread between ... which the tail is included. The thumb alone is free ... in locomotion during the awkward attempts of most Bats to ... on all-fours. The hind-limbs, which in ordinary Ma... propel the body forwards, are almost entirely relieved ... office, being singularly weak and feeble, and of lit... to the animal except while asleep or resting, when ... the sharp claws, with which the hind-toes are furnishe... some support, and remains suspended with the head d... until again ready to fly.

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The Chiroptera are divided into two ... and Insect-eating Bats. The mem... which are confined to the Old W... size, with flattened back-teeth, ... with claws both on the first ... latter are of smaller size, wi... for crushing insects, and wit...

[Case 16.] Of the Fruit-eating B... (*Pteropodidæ*) exhibite... mention are the la... Flying-Foxe... Fruit-...

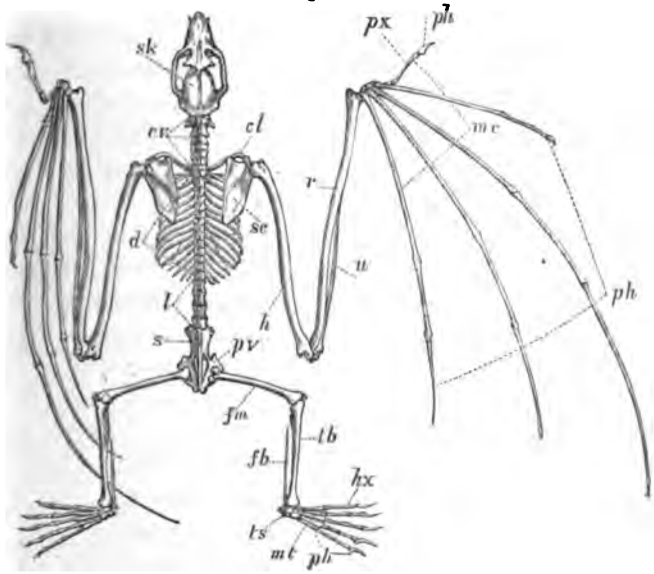
The third family of Lemuroidea, the *Tarsiidæ*, contains a single genus only. The Tarsiers, *Tarsius spectrum* (**220**) and *fuscomanus*, are extraordinary little animals about the size of a rat, with 34 teeth, very long feet, long tufted tails, and extremely large eyes; they are natives of the islands of the East-Indian Archipelago.

Order II. CHIROPTERA.

(Upper Gallery, Cases 16 and 16*.)

The Bats, or Chiroptera, form one of the most sharply defined of all the orders of Mammalia, having the fore-limbs modified into

Fig. 13.



Skeleton of a Fox-Bat or Flying-Fox.

cl, clavicle; *cv*, cervical vertebræ; *d*, dorsal vertebræ; *fb*, fibula; *fm*, femur; *h*, humerus; *hx*, great toe, or hallux; *l*, lumbar vertebræ; *mc*, metacarpals; *mt*, metatarsals; *ph*, phalanges; *pv*, pelvis; *px*, thumb, or pollex; *r*, radius; *s*, sacral vertebræ; *sc*, scapula; *sk*, skull; *tb*, tibia; *ts*, tarsus; *u*, ulna.

wings. The structure of a Bat's wing is very simple: it consists of a framework formed by the bones of the arm and the enormously elongated fingers, between which the flying membrane

Of the Insectivorous Bats exhibited, the following may be noticed:—The False Vampires, *Megaderma* (**343**) of Africa, Asia, and Australia, which correspond among Bats to the Carnivora among Mammals generally, preying habitually on the smaller species of Chiroptera; the Horseshoe-Bats of Europe, *Rhinolophus ferrum-equinum* (**320**) and *R. hipposiderus* (**324**); the Long-eared Bat, *Plecotus auritus* (**341**), whose ear is nearly as long as its body; the Noctule, *Pipistrellus* (*Pterygistes*) *noctula* (**361**),

Fig. 15.

A B

Skulls of (A) the Noctule and (B) a Blood-sucki[illegible]

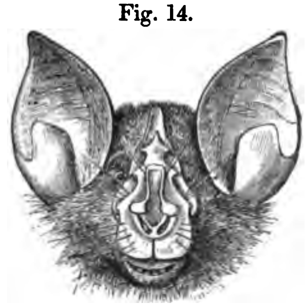
the largest of the English Bats; the peculiar-looking [illegible] *Chiromeles torquatus* (**380**), of the Malay countries; the [illegible] *Diclidurus albus* (**381**), of South America; the [illegible] *Kerivoula picta* (**369**), of India, whose orange-and [illegible] closely resemble the fruit and decaying leaves of [illegible] among which it lives. Among the Vampires may [illegible] the Lesser Vampire, *Vampyrus auritus* (**397**), a[illegible] Vampire (**398**), both well-known South American s[illegible] of these American Bats were formerly supposed [illegible] blood-sucking; but one of the three real Blood[illegible] is *Desmodus rufus* (**400**), of which a specimen [illegible] Mr. Darwin in the act of sucking blood from a [illegible] Bats attack men as well as animals in their sleep [illegible] victims with their wings. The wounds they inflict a[illegible] often continue to bleed after the Bats are satisfied, [illegible] readily heal.

ß/

is extremely common all over India, where it inflicts enormous damage to fruit-gardens, to pillage which these Bats will often make nightly expeditions of from ten to twenty miles, returning each morning to their accustomed sleeping-places. In striking contrast to these great animals is the small *Rousettus amplexicaudatus* (**308**). Another noticeable group contains the Tube-nosed Bats, *Cephalotes* (**312**, **313**), whose nostrils are elongated into peculiar tubes, the special use of which still remains to be discovered; they range from Celebes to Australasia. Fruit-Bats are spread over all the tropical parts of the Old World, *Pteropus* being unrepresented in Africa, where its place is taken by the Epauletted Fruit-Bats, *Epomophorus* (**314–316**), and the Hammer-headed Bat, *Hypsignathus monstrosus* (**317**), of West Africa.

The Insect-eating Bats, or Microchiroptera, exhibited in the central case, No. 16*, are much more numerous, being [Case 16*.]

Fig. 14.



Head of the Indian Horseshoe-Bat (*Rhinolophus mitratus*).

distributed over the whole world, and extending even to remote islands in the Pacific, where they are the only indigenous Mammals. With few exceptions they are of dull coloration. Though in other respects much alike, they present striking modifications in their facial characters, many of them developing on their muzzles structures, known as nose-leaves, which seem to be organs of touch of extreme delicacy, and are of wonderful variability both in shape and size (see fig. 14). Another feature of Bats, especially those in which the nose-leaf is small or absent, is the presence of a kind of an additional ear, or "tragus," within the main ear.

Of the Insectivorous Bats exhibited, the following may be noticed:—The False Vampires, *Megaderma* (**343**) of Africa, Asia, and Australia, which correspond among Bats to the Carnivora among Mammals generally, preying habitually on the smaller species of Chiroptera; the Horseshoe-Bats of Europe, *Rhinolophus ferrum-equinum* (**320**) and *H. hipposiderus* (**324**); the Long-eared Bat, *Plecotus auritus* (**341**), whose ear is nearly as long as its body; the Noctule, *Pipistrellus* (*Pterygistes*) *noctula* (**361**)

Fig. 15.

A

Skulls of (A) the Noctule and (B) a

the largest of the English Bats; the
Chiromeles torquatus (**380**), of the N
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Kerivoula picta (**369**), of Ind
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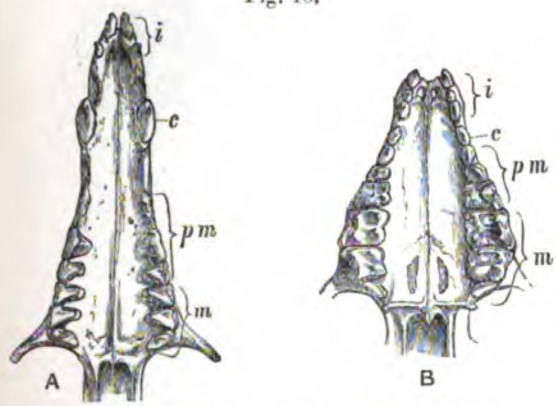
among which it lives. Am
the Lesser Vampire, *Vam*
Vampire (**398**), both well
of these American Bats
blood-sucking; but
is *Desmodus rufus* (
Mr. Darwin in the
Bats attack men as
victims with their wi
often continue to ble
readily heal.

Order III. INSECTIVORA.

(Upper Gallery, Case 15.)

The small order of Insectivora, or Insect-eating Mammals, is a group of which the English Hedgehog, Shrew, and Mole are familiar examples. The members of this group are small Mammals, of dull and inconspicuous coloration, gaining their living either by burrowing in the ground for worms and grubs, by hunting for

Fig. 16.



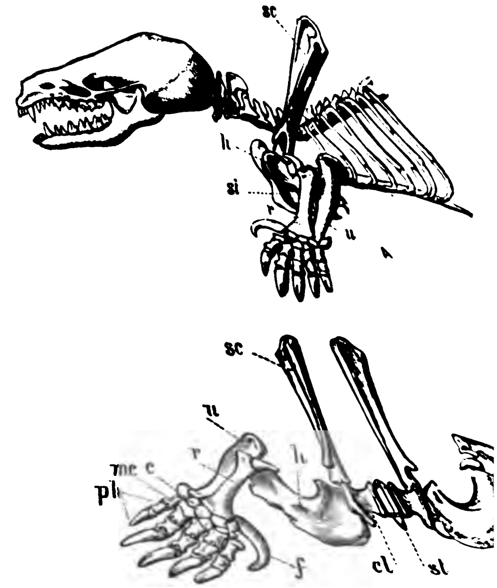
Teeth of (A) the Tenrec and (B) the Hedgehog.
c, canines; *i*, incisors; *m*, molars; *pm*, premolars.

beetles and other insects in grass and underwood, or, more rarely, by climbing among trees after their prey. By far the greater portion are purely animal-feeders. Their voracity is extraordinary, instances being recorded, both of Moles and Shrews, in which, when two individuals kept in the same cage have attacked each other, the victor has eaten the whole of its opponent, leaving only the skin. A fast of only three or four hours is fatal to most of them; so that the total number of worms and insects destroyed by the members of this order must be enormous. The range of the Insectivora extends over the whole world, with the exception of Australia and almost the whole of South America.

Insectivora are not an easily defined group since they contain many species in which certain parts of the skeleton

are remarkably modified. Their teet...
developed, and, in the majority, clearly se...
usual divisions; but in some, such as the Shrews a...
the incisors, canines, and premolars are by no means rea...
distinguished from one another. Throughout the order the
premolars and molars are surmounted with minute, pointed cusps,

Fig. 17.



Fore part of the Skeleton of the Mo...
view of sh...

c, carpus; cl, collar-bone, or clavicle; f, ...
carpus; ph, phalanges; r, radiu...

suitable for crushing the ins...
from their name, nearly al...
cheek, arches are general...
dentition offers many ...
(*Myogale*) have enor...
opposite is the ca...
(*Centetidæ*). Th...
Vera, are divided...

the molars, which are either triangular and 3-cusped, as in the Tenrecs and Golden Moles, or square and many-cusped, as in the Hedgehogs, Moles, and Shrews (fig. 16, A & B).

Skeletons of the chief types are exhibited; the most noteworthy are those of the Moles (*Talpa*), fig. 17, in which the *humerus* (*h*) is enormously large, strong, and ridged, to afford insertion for the powerful digging-muscles; the *scapula* (*sc*) is long and straight; and the fore-foot, in addition to its proper complement of five toes with strong nails, possesses a much enlarged sickle-like bone (*f*), adding to the breadth and strength of the palmar surface. The pelvis or hip-bone is much compressed, in order that the hind-legs, which are comparatively weak and small, should not project too much laterally.

The order is divided into the typical Insectivora, or Insectivora Vera, and the Dermoptera, represented only by the aberrant Flying Lemurs. In the former group we have, firstly, the Tupais, or Tree-Shrews (*Tupaiidæ*) of India and Malaysia, which are so like Squirrels both in appearance and habits as easily to be mistaken for them. They feed on various insects, and also to a small extent on fruit, and are the only Insectivores which habitually seek their food by day. There are numerous brightly-coloured, bushy-tailed, species belonging to the family, mostly referable to the genus *Tupaia* (fig. 18, **286–289**); but there is also the curious little pen-tailed Tree-Shrew, *Ptilocercus lowi* (**290**).

The Jumping Shrews, or Elephant-Shrews (*Macroscelididæ*), are long-nosed and long-legged little animals, natives of Africa, which use their long hind-legs for leaping about over the sand, like kangaroos or jerboas, seldom putting their fore-feet to the ground. This modification for leaping is very common in animals living in tracts of desert country, as it facilitates progress over deep loose sand. The largest members of the family belong to the genus *Rhynchocyon* (**264**), of which stuffed specimens and a skeleton are exhibited; several species of the typical genus *Macroscelides* (**268–270**) are also shown.

The *Erinaceidæ* include the Hedgehogs (*Erinaceus*, **247–249**), of which there are numerous species, all extremely similar to the English Hedgehog, both in appearance and habits, and distributed over Europe, Africa, and Asia; the Rat-Shrew, *Gymnura*

(**245**, **246**), a long-tailed animal, closely related to the Heag hogs, but looking externally much more like a large rat; an *Hylomys* (**244**), also rat-like, but much smaller and with a ver short tail; the two latter are natives of Malacca, Sumatra, an Borneo.

In the Mole family (*Talpidæ*) we have, firstly, the long-tailed Desmans, *Myogale*, one species of which, *M. moschata* (**278**), lives in the neighbourhood of the Caspian Sea, and the second

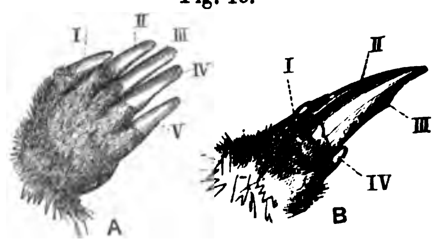
Fig. 18.

A Tupai, or Tree-Shrew (T... upaia tana).

M. pyrenaica (**279**), in the Pyrenee... They are ... in their habits, living on water ... insects and ... they obtain by the help of th... eir long an... snouts. Their feet are edged with stiff br... swimming, and, for the same purpose, th... from side to side. The Moles, T... a considerable number of species, among themselves in the structu... are long-nosed, short-tailed ... velvety fur, of such a str... direction, thus enabling either backwards or ... their short, broade... and all of near...

.t instruments Moles are able to force the earth ·ow it backwards while burrowing in the ground. ‿-habits of the Mole are illustrated in a special case ion at the end of the bird-gallery on the ground floor. America the Moles are represented by several distinct ıch as *Scapanus* (**271**) and *Condylura* (**277**), the latter e curious Star-nosed Mole. In Japan there is the Mole- *Urotrichus* (**273**), represented by a closely allied species th America.

Fig. 19.



A, Fore-foot of Mole. B, Fore-foot of Golden Mole.
The digits are distinguished by numerals, the fifth being absent in the Golden Mole.

The hrew-Mice (*Soricidæ*) form a family containing a very large number of Mouse-like animals, differing from each other mainly by slight variations in their teeth, but all presenting very much the same external appearance. The great majority are terrestrial in their habits, as, for example, the English Common and Pigmy Shrews, *Sorex araneus* (**252**) and *S. minutus* (**253**), burrowing on or close to the surface of the ground, and living on small beetles, worms, or any other animal food they can obtain. The large Indian Shrews, *Crocidura* (**257–260**,) are provided with scent-glands, by means of which a substance of a most penetrating odour is secreted. Others live in ponds and streams, feeding on water-beetles and crustaceans, after which they swim and dive with great facility. To this group belongs the British Water-Shrew, *Neomys fodiens* (**250**), a beautiful velvet-coated animal with a long tail, and having feet provided, like those of the Desmans, with lateral swimming-bristles.

The family of Tenrecs (*Centetidæ*) is confined to Madagascar,

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in either
r burrows
rkable for
eing strong
With these

and consists of several genera and spe
mentioned the Spiny Tenrecs, *Centetes*
of the order, and the Striped Tenrec
The Long-tailed Tenrecs, *Microgale* (
the length of their tails; and there
Oryzoryctes (**237**), and the aquatic
To these is allied *Potamogale* re
Africa, which in habits resembles th

Fig. 20

The Flying-Lemur

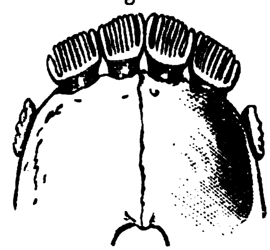
and feeding on small fis
more curious is *Solenod*
of a family by itself, on
being practically no re
South America.

The last family is the
natives of South Africa
shape, but distinguish
different form of thei

and each provided with an enormous central claw, the outer toes being quite small (see fig. 19, B). Several species of *Chrysochloris* (**240**, **241**) are shown, some remarkable for the iridescence of their fur, which fades when it is dried and stuffed.

The Taguans or Flying-Lemurs, *Galeopithecus* (**284**), of the Indo-Malay countries represent the group Dermoptera, which is classed by some with the Insectivora and by others as a distinct order. These animals are about the size of a cat, with a lateral extension of the skin of the body, supported by the four limbs and tail, and forming a sort of parachute, by the help of which they can float through the air for considerable distances from tree to tree; but their

Fig. 21.



The Lower Incisor Teeth of the Flying-Lemur.

flying leaps are always in a descending direction, as in Flying-Squirrels and Flying-Lizards, and, unlike the flight of Bats, Flying-Lemurs live exclusively on vegetable food. In the skeleton the radius and ulna are partly joined together, in order to render the fore-arm more rigid; the hip-bones are united below by a long bony union; and in the skull the muzzle is broad and flattened, the socket of the eye nearly surrounded by bone, and there are well-developed cheek-arches. The dentition of these animals is altogether unique, especially the lower incisor teeth (fig. 21), which are of a very remarkable pattern, being so deeply notched as to appear like minute combs.

Order IV. CARNIVORA.

(Lower Gallery, Cases 17–30& A–G.)

The Carnivora comprise the animals known by the name of Beasts of Prey, such as Cats, Wolves and Dogs, Bears, Weasels, and allied mammals. From this terrestrial type (Carnivora

Fissipedia) has been developed another, adapted for an aquatic life, with limbs modified into swimming-organs, viz. the Carnivora Pinnipedia, or Fin-footed Carnivora, as represented by the Seals and Walruses.

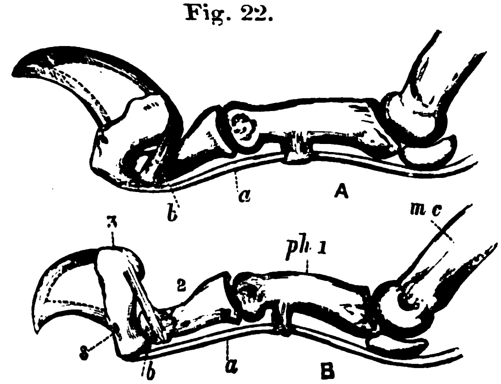
The Carnivora form a large and natural division of Mammals, distinguished by their specialized double sets of teeth; the second or permanent set being almost invariably made up of three incisors on each side, above and below (of which the outer is the largest), one long, sharp, and powerful canine or eye-tooth, and a variable number of molars and premolars. They are also well characterized by their clawed toes, of which there are never less than four on each foot, non-opposable first toes, and incom... or absent clavicles.

In the Land Carnivora, or Carnivora Fissipedia, the ... etons are such as to represent perfectly the normal Mamm... an typ figured on p. 6. The limbs are adapted for walking ... runnin and climbing, but are not specially modified for swim... ing, as a those of the second group. The zygoma, or cheek-ar... of the sk is broad and powerful, in correlation with the great ... developmen the biting-muscles; and the lower jaw is articu... ted to the s by a closely fitting transverse hinge, which give... great strength firmness to the joint, but deprives the an... al of the pow moving the jaw backwards and forwards, ... from side to sid only motion being in a vertical direction ... The varied and h developed dentition differs from that of other Mammals b development of the last premolar of the upper jaw and th molar in the lower into the so-called "sectorial" or "carna teeth, which are specially adapted for cutting up animal food shape of these teeth is highly characteristic of the different

[Cases -19.] The Cats, or *Felidæ* (cases 17 to 19), are the most hi ganized of all the Beasts of Prey, representing the of animal in its fullest perfection. They are built, with small heads, short ears hairy tails, which are ... digitigrade—that ... not on th... on th... the ...

Their sharp, powerful, and strongly-curved claws .e, *i. e.* they can be drawn back when not in use, to ·em from being blunted by contact with the ground; ·anism of this retraction being explained below. In ·ion the Cats belong to the fiercest of animals, and man has ·ded in taming, to a certain extent, only one member of the ·p, the common Domesticated Cat. All the other species become ·age and bloodthirsty when adult, even if, as kittens, they are ·pparently docile and attached to their masters. The geographical distribution of the Cats extends over the whole world, with the exception of Madagascar and the Australian region. The Cats have unusually long and powerful canine teeth, admirably suited for seizing and killing their prey, and sharp-edged scissor-like sectorial

Fig. 22.



Bones and Tendons of Toe of the Cat. A, with retracted, and B, with extended claw.

a, tendon of extensor muscle; *b*, retractor ligament; *mc*, metacarpal; *ph* (1, 2, and 3), 1st, 2nd, and 3rd phalanges; *s*, bony sheath, into which the claw is fixed.

teeth, equally well adapted for cutting up flesh or breaking and crushing bones, which form an essential part of their food. The actual number of teeth, however, is much reduced, the dental formula being I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{3}{2}$, M. $\frac{1}{1} \times 2 = 30$; and the whole jaw is shorter in comparison with the length of the head, and therefore proportionally stronger. In the limbs the most noticeable characteristic is the peculiar shape and articulation of the toe-bones, which have direct reference to the power Cats possess of retracting

the claws. Fig. 22 A shows the bones of a toe with the claw in ordinary retracted state; when the animal wishes to strike, the tendon (*a*) is drawn back, and the whole terminal phalanx (3) with the claw attached is drawn downwards and forwards, as in B. At other times the claw is drawn back and kept from contact with the ground by an elastic ligament (*b*). The sheath (*s*) into which the claw is fixed is present in all Carnivora, but in no other is it so much developed as in the present family.

[Case 17*.] Of the Lion, *Felis leo* (**410**), there is exhibited a fine male from British East Africa, presented by S. L. Hinde, Esq., in 1897, a smaller male Lion from Somaliland, presented by Col. Arthur P... et; a Lioness from South Africa, and the fore-quarters of a Barbary Lion, presented by Rowland Ward, Esq. Lion-cubs show traces of the dark spots so general in the family of Cats. The present range of the Lion extends over the whole of Africa, through Persia to the north-western corner of India.

[Case 17.] In case 17 is placed a specimen of the Ounce or Snow-Leopard, *Felis uncia* (**417**), a beautiful, soft-furred, long-tailed species, which inhabits the snowy regions of the Himalaya and Central Asia, at elevations varying, according to the season, from 9000 to 18,000 feet above the sea, never ranging very far below the snow-line. The same case contains specimens of the different races of Leopard, *Felis pardus* (**412**), one of the largest of the spotted Cats. Its range extends over all Africa and Southern Asia as far as Persia and Tibet. In India it is extremely destruc... and other domestic animals, and aged indivi... become "man-eaters." The Jaguar, *Felis o*... regarded as the American representative of ...

[Case 19*.] The Tiger, *Felis tigris* (**411**), case 19... dangerous of the *Felidae*, exceeding ... far surpassing it in destructiver... ornamented with cross-stripe... scarce among Mammals. ... animal inconspicuous ... hides itself, and ... marked with ... nearly the ... and so...

.s not found in either Ceylon or Borneo. .hibited of the smaller, softer-furred variety of .y large, short-haired Bengal form, and also of the .uilt, and long-haired Siberian race.

.er species of Cats exhibited to the public, the most are the tropical American Ocelot, *F. pardalis* (**435**), .nier's Cat, *F. tristis* (**437**), of Tibet, and the Clouded *F. nebulosa* (**418**), of Assam and the Malay countries, .e its Asiatic representatives. The African Serval, . (**427**); the long-haired Tibetan Pallas's Cat, *F. manul* and the Kaffir Cat, F. *ocreata* (**425**), from the Egyptian .tative of which Domesticated Cats originated, are also The Lynxes (case 19), which differ from the ordinary Cats . short tails, tufted ears, and certain peculiarities in their .nd dentition, are confined to the North Temperate and .zones of both the Old and New Worlds. The species .nted include the Common Lynx, *F.* (*Lynx*) *lynx* (**444**), the .rn Lynx, F. (L.) *pardina* (**452**), and the Caracal, *F.* (*L.*) .l (**448**). [Cases 17-19.]

most aberrant member of the *Felidæ* is the Hunting Leopard 19), usually called in this country the Chita, characterized small round head, light and slender form, semi-retractile and various other peculiarities, both osteological and external. . native of a large part of Africa and India. In India it is .d for hunting antelopes and similar game. Its speed at , and for short distances, is marvellous, surpassing that of a .orse; and, when well trained, it always runs down its quarry, .gh in the wild state it uses the same tactics as other Cats stalking its prey, availing itself of every inequality of the .id to steal close up to a spot whence it can suddenly spring the unsuspecting victim. It is referred to a genus by itself, r the name of *Cynælurus jubatus* (**447**).

.. case 17 is placed a cast of the skull of the great extinct South

animals, of low build and dull coloration, with long hairy tails; they are entirely confined to Africa and Southern Asia, with the exception of two species which are found in South-western Europe. They are in all respects less highly specialized for carnivorous habits than the Cats, their teeth being more numerous and far weaker than those of the latter. The following are the most noteworthy groups:—*Cryptoprocta*, containing but one species, the Foussa, *C. ferox* (**454**), peculiar to Madagascar, and the largest Carnivore of that island. This animal is remarkable for its Cat-like head, retractile claws, and other feline characters; it is quite untamable, and excessively savage when caught or wounded. The Civet-Cats, *Viverra* (**463—465**), of which there are four species, one African and three Indian, have hairy soles and partially-retractile claws; these animals produce in a pouch beneath the tail the scent known as civet, which is obtained by the natives
from individuals kept in captivity for the purpose. The Genet
Genetta (**458, 459**), of which there are several African speci
are smaller than, but very similar to, the last; one of them,
Common Genet, *G. vulgaris*, or *G. genetta* (**459 a**), extends
Europe as far as Central France. The beautiful Oriental an
known as Linsangs, *Linsanga* or *Prionodon* (**478**), with thei
African relative *Poiana* (**477**), find a place here. The Palm
Paradoxurus (**471—476**), are long-bodied, short-limbed
with short ears, long, powerful, hairy tails, naked soles,
retractile claws, common in India and the Malay Ar
They are arboreal in their habits, and feed either on r
small birds and eggs, or on vegetable food, such as ri
In Africa they are replaced by the allied genus *Na*
[Case 21.] **469**). The Mungooses, *Herpestes* (**493—503**) &c.,
India, have naked soles, and long, straight, nor
They feed on reptiles and birds, rats an
and are often domesticated for the purpo
vermin. They are most useful in d
whose bites they avoid by their wor
the stories of their having reco
the snake's poison being
about 30 species of Mun
are the Egyptian M

found also in Spain, and feeds largely on the eggs and young of the crocodile; and the Indian Mungoose, *H. mungos* (**498**), the species tamed in India. Many of the African Mungooses are referred to separate genera; among the best-known being the Kusimanses, *Crossarchus* (**491, 492**), of which one species is banded, and the Meerkat, *Suricata* (**488**), the latter being easily tamed.

More or less nearly allied to the Mungooses are several peculiar species from Madagascar, among which may be specially mentioned *Eupleres goudoti* (**483**), exhibited in case 21, which obtains the beetles and worms on which it lives by burrowing in the earth with its elongated snout. Its teeth are so reduced in size as to resemble those of the Insectivora.

Fig. 23.

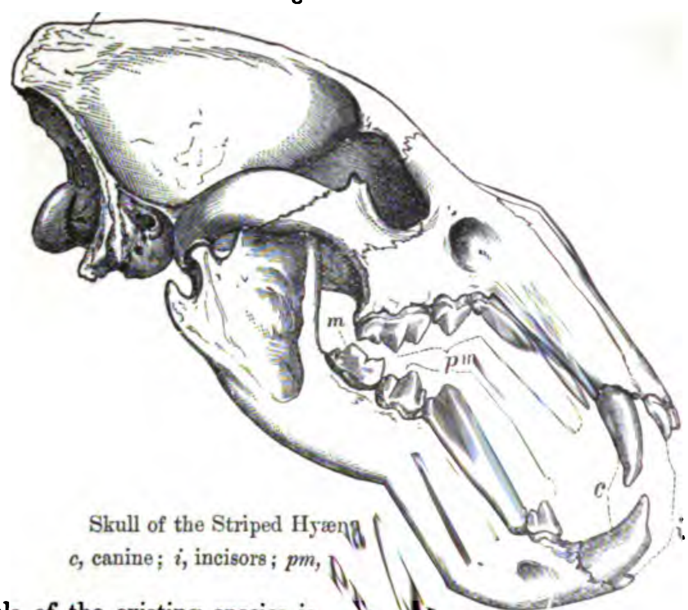
Skull of the Aard-Wolf (*Proteles cristatus*).
c, canine; *i*, incisors.

The Maned Jackal, or Aard-Wolf of the Dutch Boers of South Africa, *Proteles cristatus* (**505**), of which there is a specimen in case 21, looks like a diminutive Hyæna, but has very feeble teeth, as it lives nearly entirely on decomposing carcases, and on termites or white ants, which its strong claws enable it to dig out of their nests. It is found throughout Africa, from Abyssinia and Somaliland to the Cape. The molar teeth are almost rudimentary, and the skull (fig. 23) has no strong ridges or crests. By some naturalists this animal is taken to indicate a separate family; but by others it is included in the *Hyænidæ*.

The family *Hyænidæ* comprises the Hyænas (case 21), of which there are three well-marked living species, *Hyæna striata* (**506**) and [Case 21.]

brunnea, the Striped and Brown Hyænas, and *Hyæna crocuta* (508), the Spotted Hyæna of South Africa. They are of about the size of a large Wolf, of cowardly and nocturnal habits, feeding for the most part on carrion, and rarely attacking animals which are able to defend themselves. They have four toes on each of their feet, non-retractile claws, and a rather short, hairy tail. Hyænas are specially characterized by the enormous power of their teeth and jaws and the great height of the crests on the skull for the attachment of the biting-muscles. The dental

Fig. 24.



Skull of the Striped Hyæna (*Hyæna striata*).
c, canine; *i*, incisors; *pm*, premolars; *m*, molars.

formula of the existing species is I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{3}$, M. $\frac{1}{1} \times 2 =$ Certain extinct species have, however, rather more teeth, and some of them appear to form a connecting link between the mo Hyænas and the Civets.

[Cases 21*–22.] The families above-noticed are nearly related in the chara of the skull, especially those connected with the organ of hea but in the Dog tribe, or *Canidæ*, a marked difference is obse in this respect. The Dogs, Wolves, and Foxes, which con this family, are on the whole lightly-built animals, of gre and endurance, obtaining their prey, as a rule, by runni

n by pouncing upon it in the manner of the Cats and s. They are digitigrade, and, with a single exception, toes on their fore and four on their hind-feet; their palms les are always hairy, the only naked parts being the pads of eet. The various members of the family are all much alike heir osteological and dental characters; their skulls are more ngated than those of the Cats, and their teeth (fig. 2, p. 7) nore numerous and less highly specialized. Not having the power of retracting the claws, their toe-bones have none of the peculiarities of those of the Cats, but otherwise the bones of the skeleton are generally similar to those of the latter.

The teeth are usually 42 in number, viz. I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{2}{3}$. In one species, the South-American Bush-Dog, *Speothus venaticus*, there are, however, 38 only; while in another, the African Long-eared Fox, *Otocyon megalotis*, the number is increased to 46 or 48.

This family contains a large number of species, all more or less closely allied to each other, with the exception of one or two peculiar kinds. The principal genus is *Canis*, which comprises Dogs, Wolves, and Jackals.

The history of the development and domestication of the Dog, *Canis familiaris*, is a subject as yet far from fully understood. Many naturalists, till within a recent period, entertained the view that there had existed one original wild species from which, by man's agency, all the various breeds were developed. This view has now been abandoned; in its place it is believed that in many parts of the world the natives have tamed the wild species of their own country, and that in course of time, as certain nations became more civilized, their Dogs were more and more adapted to their various requirements by careful breeding, and by the selection and perpetuation of the most useful varieties, until many of them ceased to show resemblance to their far-distant wild ancestors.

In support of this view the fact may be adduced that at the present day, among savage and primitive tribes, the tame Dogs bear a striking resemblance to the wild species found in their

triata).
m, molars.

$\frac{1}{1}$, P. $\frac{4}{3}$, M. $\frac{1}{1}\times 2=34$.
rather more teeth, and
link between the modern

ly related in the characters
d with the organ of hearing,
marked difference is observable

known to train and domesticate the indigenous Wild Dogs. In the Old World the Hungarian Sheep-Dog might be readily mistaken for the European Wolf (*Canis lupus*), the Street-Dogs of Constantinople and Cairo for Jackals, and certain of the Indian Pariah Dogs for individuals of the Indian Wolf (*Canis pallipes*). The Bushmen of South Africa have a tame Dog which agrees in many of its characters with the Black-backed Jackal (*Canis mesomelas*) of that region.

Thus there can be no doubt that these tame or semi-domest cated Dogs are individuals of the same stock as the wild specie the country, with which indeed they readily mix whenever cease to be under the control of their masters.

In more civilized countries the process of domesticati selection has gone so very much further, that the D gradually lost nearly all traces of their wild ancestry, and into the innumerable different breeds now existing distinct that, were they natural instead of artificial, t referred to several different genera. Representativ number of these breeds, inclusive of the Pariah Do Egypt, and of the Dingo, or Australian Dog, are north hall with the other domesticated animals.

Dogs were domesticated by man long before t of history, their remains being found in associ implements of the ancient cave- and lake Europe.

[Cases 21*–22.] In case 21* are the Wolves. The spec the European Wolf, *C. lupus* (**517**), the A (**510**), and the great Alaskan Black W the latter represented by a specimen pre The Prairie-Wolf or Coyote, *C. latra* and the very different Red or Mane South America, are also shown. T (in the same case) are smaller in s *C. aureus* (**523**), *C. adustus* (**525**), range all over Europe, continental

Among the Foxes (*Vulpes*) may *V. alopex*, or *V. vulpes* (**543**), the *V. pennsylvanica* (**541**), and others.

Fox, *V. lagopus* (**540**), one of the most important fur-bearing animals, changes the colour of its coat according to the season, like many other Arctic animals; but the blue phase retains its colour all the year round, and yields in winter a fur more rich and valuable than the white.

The beautiful large-eared Fennecs (case 22) of Africa are closely allied to the Foxes. With these is placed a specimen of the Long-eared Fox of South and East Africa, *Otocyon megalotis* (**535**), noticeable for its very numerous teeth and sharp-pointed and long ears.

The African Hunting-Dog, *Lycaon pictus* (**518**), so remarkable for its external similarity to a small Spotted Hyæna, forms a genus by itself, readily characterized by having but four toes to each foot (case 21*). Another peculiar genus is represented only by the Bush-Dog, *Speothus venaticus* (**548**), of Guiana and Brazil, an example of which is exhibited in case 22. Its molar teeth are quite unlike those of other members of the family. The Wild Dogs of Asia (case 21*) are related to the Hunting-Dog, but since they have five front toes, fewer teeth, and other characteristic points of difference, they are regarded as representing a separate genus, under the name of *Cyon*; the species represented being the Central Asian *C. alpinus* (**519**) and the Indian *C. deccanensis* (**521**). [Cases 21* & 22.]

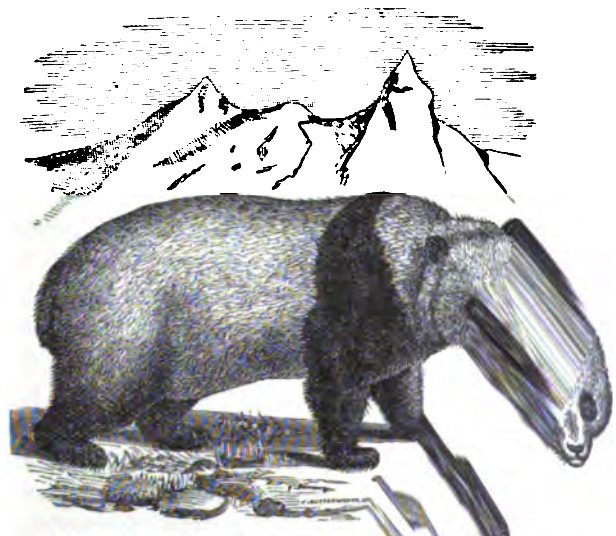
With the Raccoon tribe, or *Procyonidæ* (case 23*), we come to the first of three families of Land Carnivora which differ from all the foregoing members of the order in regard to the conformation of that part of the skull connected with the internal organ of hearing. The more typical members of this assemblage are completely plantigrade, walking on the soles of their feet; the great majority having five toes to each foot. [Case 23*.]

The *Procyonidæ* are typically American, and contain, among others, the Raccoons, *Procyon* (**582**), the peculiar long-nosed Coatis, *Nasua* (**583, 584**), and the Kinkajou (*Cercoleptes*, or *Potos*), the last a nocturnal animal with a long prehensile tail. All the members of this family habitually live largely on vegetable food, such as fruits, berries, &c., as well as on small mammals, birds, insects, worms, eggs, &c.

The brilliantly-coloured Panda, *Ælurus fulgens* (**586**), exhibited in the same case, is one of two Asiatic representatives of the

family, and occurs in the north-eastern Himalaya and the mountains of Assam, whence it ranges into North-Western China. It lives at a considerable altitude in the Himalaya, seldom descending lower than about 7000 feet above the sea, and feeds wholly on fruits and other vegetable food. Remains of a large extinct species have been found in the Upper Tertiary formation of England. The other Asiatic species is the Great Panda, *Æluropus melanoleucus* (**587**, fig. 25), a short-tailed black-and white animal, inhabiting Eastern Tibet and North-Western China, long regarded as a Bear.

Fig. 25.



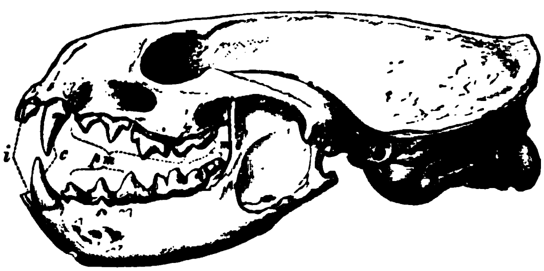
The Great Panda (*Æluropus melanoleucus*).

[Cases 23 & 24*]

The family *Mustelidæ* (cases 23 and 24*) contains the W… Otters, Badgers, &c., which agree closely in the characters … skulls and teeth, but may be separated into three groups b… general form, and the structure of their feet and claws. Thes… are:—(1) The *Mustelinæ*, or Weasel group, the members o… have long, low bodies, with short legs, short and partly webb… and small, sharp, and often semi-retractile claws. The fur of the species forms an important article of trade, as of the … and Sables, *Mustela* (**563—568**), of Northern Europ…

ese one species is British, namely the Pine-Marten, **55**), now nearly exterminated in England, but still wn in the wilder parts of Scotland. The true Weasels, **0—561**), comprise a number of comparatively short-es, inhabiting nearly all parts of the world. Among e mentioned the Stoat or Ermine, *Putorius ermineus* , specimens of which have been mounted to show the iange of fur; the Weasel, *P. nivalis* (**553**); and the *fœtidus*, or *P. putorius* (**558**), of which the Ferret is a ed form. The African *Pœcilogale albinucha* (**569**) is est marked of the group; and its largest member is the ar Glutton, *Gulo luscus* (**577**), a heavily built, powerful uch resembling a small Bear, and very destructive to the ame. (2) The *Melinæ*, or Badger group, have com-y stout, thick-set bodies, covered with fur generally with more or less sharply contrasted black and white bands es, and long toes provided with large straight claws, more il on the fore than on the hind feet. They include the

Fig. 26.



Skull of the Otter (*Lutra vulgaris*).
i, incisors; *c*, canines; *pm*, premolars; *m*, molars.

dgers, *Meles* (**606—607**), Ratels, or Honey-Badgers, *Mellivora* [Case 24.] **73**), and Skunks, *Mephitis* (**599, 600**), *Conepatus* (**596—598**), d *Spilogale* (**601**), the latter conspicuous for their black-and-hite coats, but having a bad reputation on account of the intensely sagreeable and evil-smelling fluid they emit when provoked.) The *Lutrinæ*, or Otter group (case 24‡), have short feet, bbed toes, small claws, and long powerful tails. There are about

general proportions; the English … L. lutra (**591**), being the typical member of … peculiar is the Sea-Otter, *Latax lutris* (**594**), which … feet partially modified into flippers, somewhat as in the … This animal frequents the salt water, and was once abundant on all the coasts of the North Pacific; but owing to the merciless persecution to which it has been subjected for the sake of … valuable fur, its numbers have been so much thinned that it … sure to be exterminated unless effectual measures be taken fo… protection. Fine skins have been sold for over £200 sterling…

All the members of the Weasel tribe have thoroughly carniv… habits, and therefore strong and well-developed teeth. Sk… the Otter and Badger are mounted so as to show the teet… below. The latter animal has its lower jaw so articulate… cranium that it cannot be separated from it without brea… bone. All *Mustelidæ* have broad flattened skulls, long … bodies, short legs, and feet fitted either for running, … swimming. In the Sea-Otter the teeth are enormously … powerful, with rounded tubercular cusps well adapted … the hard shells of crabs and molluscs, on which … to feed. Alone among the Carnivora Fissipedia, th… only two lower incisors.

[Cases 25 & 26.] The Bears (*Ursidæ*), cases 25 and 26, which f… of Land Carnivora, are characterized by their … clumsy build, rudimentary tails, plantigra… blunt, and nearly straight claws, small e… In their skeletons, as in external appe… clumsily built, and their bones ar… sectorial teeth have broad surface… cutting; the whole dentition be… on vegetable as on animal … with non-retractile claws. … alike, there being few … of size and the pr… distribution includ… are entirely abse… part of South… group are …

Europe and North Asia, which was formerly found in England, having been exterminated only within historic times. The nearly allied Kashmir Snow-Bear (**617**). A dwarfed, long-haired Bear from the highlands of Tibet known as *U. pruinosus* (**615**). The Polar Bear, *U. maritimus* (**626**), the largest of the family, an excellent swimmer, and wholly carnivorous, living on seals (which it captures by stalking) and the carcases of large animals. The Grizzly Bear, *U. horribilis*, and the closely related Alaskan Grizzly, *U. dalli* (**618**), of which a remarkably fine example is mounted in case 25, are the most formidable beasts of prey of North America. The Spectacled Bear, *U. ornatus* (**622**), an interesting species, found isolated from the others in the Andes of Peru and Ecuador, no representative of this family occurring in Central America. The Himalayan Black Bear, *U. torquatus* (**625**), and the small Malay Bear, *U. malayanus* (**623**), are also exhibited. More distinct is the Indian Sloth-Bear, *Melursus ursinus* (**633**), differing from the rest in the form of its snout and the number of its teeth, which are remarkably weak. It is the only member of the family found in peninsular India.

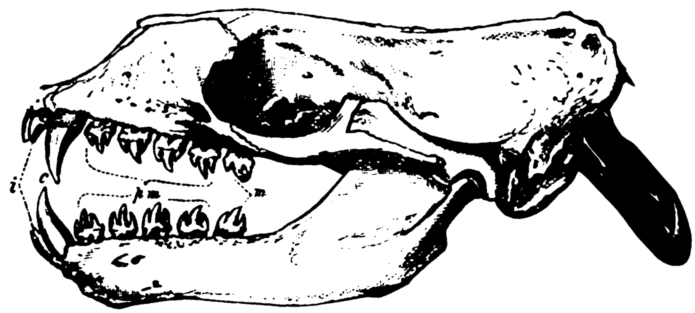
In the same case (No. 25) are shown casts of the teeth and jaws of the extinct animals known as *Hyænarctus* (**528, 529**), which, with other forms, constitute a connecting link between the Dogs and the Bears.

This case likewise contains a few casts of the remains of the still older *Hyænodon* (**632**), an animal representing a large group of extinct Carnivora which belong neither to the modern Fissipedia nor Pinnipedia, but constitute by themselves a separate subordinal group, the Creodontia. Their teeth are of a type quite different from those of existing Carnivora. Remains of numerous representatives of the group are exhibited in the Geological Department.

The Fin-footed Carnivora, or Carnivora Pinnipedia, consist of the Seals and their allies, and are distinguished by their limbs being developed into flippers, and adapted for movement in the water, while they are almost useless on land, a modification foreshadowed in the hind-limbs of the Sea-Otter. They have very short tails, close fur, and large eyes, and possess the power of closing their nostrils and ear-openings. Living for the greater part of the year in the sea, generally close to the shore, Seals sometimes wander [Cases 27–30 & F.]

far from land, to which, however, or to floating ice-floes, they ... in the breeding-season to bring forth their young. Their food consists almost entirely of fish, varied with crabs and cuttlefish, while the smaller species in their turn are preyed upon to a great extent by certain of the toothed Whales, such as the "Killer" (*Orca gladiator*). An enormous number, both of the Eared and True Seals, are killed every year by the sealers for the sake of their valuable fur and oil. The skeleton of a typical Seal (fig. 28) is elongate, with a small skull, no clavicles, rudimentary tail, and limbs of which the upper bones are very short, while the fore and hind feet are long, with five well-developed toes. The hind-legs are turned

Fig. 27.

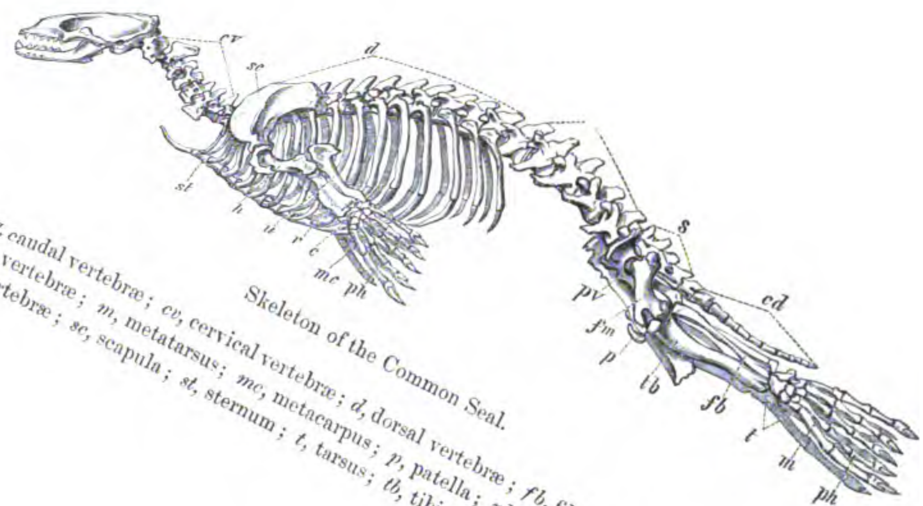


Skull of the Leopard-Seal (*Ogmorhinus leptonyx*).

Letters as in preceding figure.

backwards, so that the two soles are opposed to each other when the animal swims, the two together forming a single posterior swimming-paddle. Their action is similar to that of a person propelling a boat with a single oar worked from the stern.

The skull (see fig. 27) has no processes behind the sockets of the eyes, and the posterior teeth are different from those of the Land Carnivora, there being no specialized sectorial tooth, nor any flat tubercular teeth at the back of the mouth. All the teeth are long and sharp, with the points directed towards the throat, thus forming admirable instruments for catching and holding such slippery prey as the fishes on which Seals feed; but they are useless for biting the prey into small pieces, each fish being



Skeleton of the Common Seal.

c, carpus; cd, caudal vertebræ; cv, cervical vertebræ; d, dorsal vertebræ; fb, fibula; fm, femur; h, humerus; l, lumbar vertebræ; m, metatarsus; mc, metacarpus; p, patella; ph, phalanges; pv, pelvis; r, radius; s, sacral vertebræ; sc, scapula; st, sternum; t, tarsus; tb, tibia; u, ulna.

invariably swallowed whole. Some of the Seals have their teeth provided with additional sharp-pointed cusps along their edges, as in the Leopard-Seal, *Ogmorhinus leptonyx* (**646**), fig. 27.

This description applies fully only to the true Seals or *Phocidæ*, the *Otariidæ*, or Eared Seals, resembling ordinary Carnivores far more, especially in the position of their hind-limbs, as explained below.

In the Walruses, which are in many ways intermediate between these two families, the dentition is very remarkable, the canine teeth being enormously developed, while all the other teeth are small and rudimentary, with flattened crowns.

[Cases 27, 28.] The Eared Seals, or Sea-Lions and Sea-Bears (*Otariidæ*), are distinguished from the other members of the suborder by possessing small external ears, and being able to bend their hind-feet forwards under their bodies and to use them for walking on land, showing in both respects a closer relationship to ordinary land animals than do the true Seals, in which the outer ears have been entirely lost, and the hind-feet project straight backwards and are used only for swimming. Among the Eared Seals are exhibited very fine male specimens of the Northern Sea-Lion, *Otaria stelleri* (**534**), and of the Southern Sea-Lion, *Otaria jubata* (**535**), in case No. 27. Especially striking among these animals is the great difference in size between the male and female; all Eared Seals seem to be polygamous. Of the numerous species, one of the most worthy of mention is the Fur-Seal of the North Pacific, *Otaria ursina* (**537**), from which most of the seal-skins sold are obtained. A very fine series of this Seal, comprising specimens of both sexes and of various ages, is exhibited in case No. 27* and a skeleton in case 28; the specimens were presented by Sir G. Baden-Powell, K.C.M.G., having been obtained by him on his visit to the Commander Islands, Bering Sea. It may be observed that the coats of the stuffed specimens do not show any resemblance to the "seal-skin" of trade; in the latter only the soft under-fur is preserved, all the long coarse hairs having been removed. The difference is shown in the Index Museum.

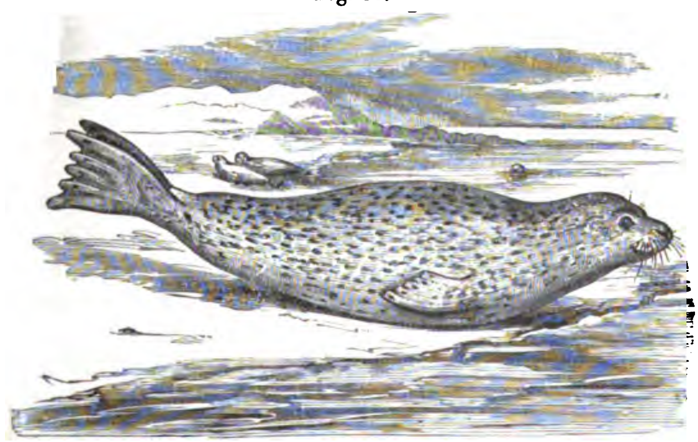
[Cases 28 & F*.] Intermediate in many respects between the Eared and the True Seals are the *Odobænidæ*, containing the two species or varieties of the Walrus, respectively inhabiting the North Atlantic and

)ceans. These animals lack external ears, but use s after the manner of the Eared Seals. In one

Fig. 29.

[ale and Female of the Northern Fur-Seal (*Otaria ursina.*)

Fig. 30.



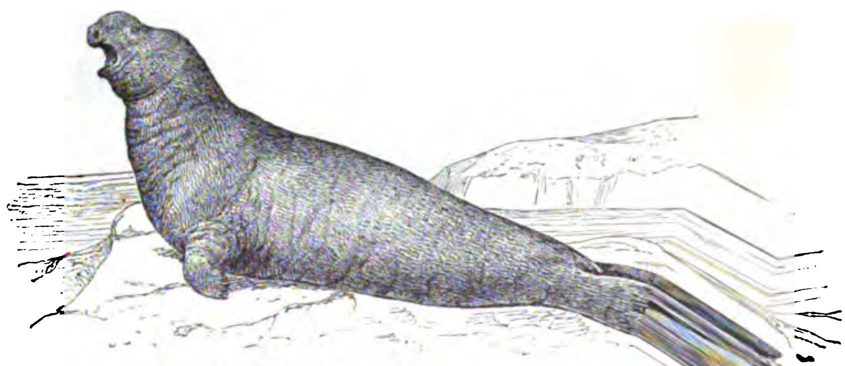
The Common Seal (*Phoca vitulina*).

spect, however, they are quite unique—namely, in the possession ' enormously long and powerful canine teeth, or "tusks," which oject downwards far below the lower jaw, and are used for fighting,

for climbing from the water on to the ice, and for digging on the sea-bottom for the shell-fish and crustaceans on which these animals chiefly live. Their range extends all round the North Pole, along the edges of the ice-fields. A complete specimen of the Atlantic Walrus, *Odobænus rosmarus* (**642**), is shown, but the Pacific *O. obesus* (**644**) is represented only by skulls. [Case F*.]

[Cases 29–30 & F.] In the *Phocidæ*, or True Seals, the adaptation for an aquatic life has reached its highest development. They are without external ears, the soles of their feet are covered with hair, and the coat has no woolly under-fur, consisting merely of long stiff hairs lying closely against the skin; so that their fur is of value only for the manufacture of coarse wearing apparel.

Fig. 31.



A Male Elephant-Seal (*Macrorhinus leoninus*).

The family contains eight or ten genera, separated chiefly by the form of their teeth and the varying development of the toes, which in some are all of about the same length, while in others the first and fifth toes are much elongated beyond the rest, in order to support the web.

The most noteworthy of the Northern *Phocidæ* exhibited are:— the Hooded Seal, *Cystophora cristata* (**651**), from Greenland, the male of which has a peculiar bag of skin on its muzzle, capable of being inflated with air when the animal is excited; the Common Seal of the English coast, *Phoca vitulina* (**662**), exhibited in the British Saloon, at the end of the Bird Gallery, the Greenland or Harp-Seal, *P. grœnlandica* (**661**), the rare Banded Seal, *P. equestris* (**663**).

the North Pacific, and the Grey Seal, *Halichœrus grypus* ([illegible]**54**).

The large case in the middle line of the gallery (No. F) contains the Seals of the Southern Seas, most of the specimens of which were collected by the "Discovery," although others are the gift of Sir George Newnes. The smaller forms include the Leopard-Seal, *Ogmorhinus leptonyx* (**646**), Ross's Seal, *Ommatophoca rossi* (**647**), and the Crab-eating Seal, *Lobodon carcinophagus* (**649**). Very different is the Sea-Elephant or Elephant-Seal, *Macrorhinus leoninus* (**650**, fig. 31), the largest member of the family. The stuffed skin shows the short proboscis characteristic of the males; a skeleton and skulls are also exhibited. The stuffed specimen and skeleton were presented by the Hon. Walter Rothschild.

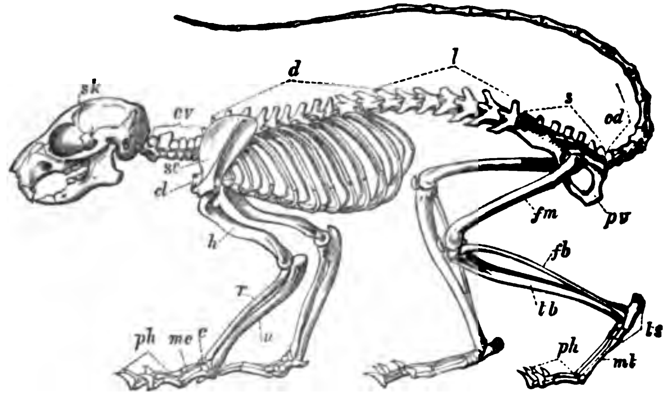
Order V. RODENTIA, or GNAWING MAMMALS.

(Lower Gallery, Cases 31–36.)

The Rodentia, or Gnawing Mammals, comprise the Squirrels, Rats, Hares, &c., and form by far the largest order of Mammals, containing over 1500 distinct species, a number more than double that of the next largest, the Chiroptera. As a whole, Rodents are distinguished by their small size, nocturnal habits, and vegetarian diet, all of them living mainly on fruits, leaves, nuts, and other similar food, although many of the species will occasionally eat eggs, birds, fish, or other animal food. They are especially characterized by their want of canine teeth and by the peculiar structure and great development of their incisor, or front, teeth. The majority have only a single pair of incisors above and below, which are large, curved, and adapted for gnawing by possessing sharp, chisel-like edges, formed by the hard outer coat of enamel, restricted to the front surface, and wearing away more slowly than the softer dentine or tooth-core. These teeth, moreover, continue to grow during the whole life of the animal from their roots as fast as they wear down at their tips. Should, however, one of them get destroyed or diseased, the corresponding tooth in the opposite jaw, which ought to have been worn down by it, continues to grow until it may even bring about the death of

the animal by preventing the mouth from closing, and thus causing starvation, or by curving right over and entering the back of the head. Examples of such abnormal developments are exhibited in the north hall. The collar-bones, or clavicles, vary in their development, being, as is usual throughout the Mammalia, complete from end to end in those species, such as the Squirrels, in which

Fig. 32.



The Skeleton of a Squirrel.

c, carpus; *cd*, caudal vertebræ; *cl*, clavicle; *cv*, cervical vertebræ; *d*, dorsal vertebræ; *fb*, fibula; *fm*, femur; *h*, humerus; *l*, lumbar vertebræ; *mc*, metacarpus; *mt*, metatarsus; *ph*, phalanges; *pv*, pelvis; *r*, radius; *s*, sacral vertebræ; *sc*, scapula; *sk*, skull; *tb*, tibia; *ts*, tarsus; *u*, ulna.

the fore-limbs are used for grasping or climbing; while they are incomplete or absent in those which live a simple terrestrial life, and use their fore-limbs for walking or digging only.

The lower jaw is attached to the skull by a longitudinal hinge, which gives a large amount of mobility and freedom at a corresponding sacrifice of strength and rigidity. This permits of the backward-and-forward movements so noticeable in a Rabbit when feeding.

Rodents, next to Bats, are the most widely spread of all Mammals, extending over the whole world, with the exception of the more remote Pacific islands, to which they have never had access.

Many of the species are arboreal, like the Squirrels, or aquatic, like the Water-Rat and Musquash; but the great majority are burrowing and terrestrial animals, which only come forth by night to seek their food, so that, although so numerous, they are little seen by ordinary observers.

The order is divided into those with only one pair of incisor teeth in the upper jaw (Simplicidentata), and those with two (Duplicidentata). The first of these suborders contains by far the greatest number of species, and is itself divisible into three sections, of which the Squirrel, Rat, and Porcupine are severally typical.

The members of the Sciuromorpha, or Squirrel section, are distinguished by always having at least one premolar, by a flattened, not twisted, lower jaw, small perforations on the palate, and by the two shin-bones, the tibia and fibula, always remaining separate. They generally have well-marked processes behind the sockets of the eyes in the skull. To this group belong the Squirrels (*Sciurus*), Beavers (*Castor*), &c.

Although it is doubtful whether they belong to the Sciuromorpha, here may be mentioned the Scaly-tailed Squirrels (*Anomaluridæ*) of Equatorial Africa (case 32, above), typically with membranous [Case 32.] parachutes like the Flying-Lemurs described above (p. 33), and with a series of pointed scales so placed under the base of the tail as to be of use when the animal is resting on a vertical tree-trunk, the points of the scales sticking into the surface of the bark. *Anomalurus* (**753**) and *Idiurus* are flying forms, but in *Zenkerella* the parachute is absent. Near by are the American Sewellels (*Aplodontiidæ*), formerly regarded as near relatives of the Squirrels, and represented only by the single genus *Aplodontia*, or *Haplodon* (**754**).

The Flying Squirrels of Southern Asia, *Petaurista* (**725** and **726**), [Case 31.] perhaps the most brightly coloured of all Mammals, belong to the family *Sciuridæ*. With the exception of the flying membrane, there is little structural difference between them and ordinary Squirrels.

The Chipmunks, or Striped Gophers, *Tamias* (**719–723**), the Susliks, *Spermophilus* or *Citillus* (**732–739**), and the Marmots. *Arctomys* (**742–748**), live in burrows of their own construction.

The Common Marmot, *Arctomys marmotta* (**746**), inhabits the Alpine regions of Europe. The North-American Prairie-Marmots, *Cynomys* (**740**), better known as Paririe-Dogs, excavate a large number of deep burrows close together, forming what is called a town. Frequently they have to share their home with weasels, burrowing owls, and rattlesnakes.

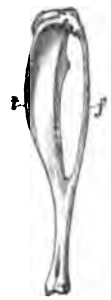
[Case 31.] The Squirrels (*Sciurus* &c.) form the largest group of the present family, distributed over the whole world with the exception of the Australian region. They range in size from species more than a foot in length, such as the Purple Squirrel, *Sciurus indicus* (**682**), of India, down to others scarcely larger than Mice, as, for example, the Black-eared Squirrel, *Nannosciurus melanotis*, and the Pigmy Squirrel, *N. exilis* (**671**), of Borneo. Squirrels are generally bright-coloured, and vary in an extraordinary degree, as may be gathered from an examination of the instructive series of *S. hypopyrrhus* (**691—715**), the Grizzled Squirrel. This species is ornamented with patches or bands of white, yellow, grey, brown, and black, in every combination, each variety passing, by insensible gradations, into the next. Specimens of the Common Squirrel, *S. vulgaris* (**678**), exhibit some of the variations observable in this species; and attention may be directed to the fine series of foreign Squirrels occupying the middle shelves on the left side of the case. The beautiful Groove-toothed Squirrel of Borneo is made the type of the distinct genus *Rhithrosciurus* (**669**) on account of its grooved upper incisors.

[Case 32.] The Beavers, *Castoridæ* (case 32), are distinguished by the flat and scaly tail, webbed hind-feet, and soft, thick fur. The incisor teeth are of remarkable strength and sharpness, and with them their owners are able to gnaw through the trunks of large trees, which they require for the construction of dams, in a short space of time. These interesting animals are rapidly becoming exterminated, owing to the great demand for their fur, so that whereas they formerly inhabited the whole of Northern Europe, Asia, and America, they are now to be found only in a few isolated localities in the most inaccessible parts of their proper range. Many naturalists regard the American Beaver as distinct from the European, *Castor fiber* (**756**), and name it *Castor canadensis* (**757**).

[Cases 32 & 33.] The Myomorpha, or Rat section (cases 32 and 33), contains numerous genera and a vast number of species, spread over the whole

world, and externally presenting few striking differences between the various species. Rats generally have large ears, long and more or less scaly tails, and bright prominent eyes. They have a

Fig. 33.



Bones of the lower Part of the Hind-leg of the Rat.
f, fibula; *t*, tibia.

variable number of premolars (0–3), a flattened lower jaw, no slits in the bony palate, processes behind the sockets of the eyes, long perfect clavicles, and the tibia and fibula of the leg joined to each other about halfway down (fig. 33).

The following families are included in this section:—The *Gliridæ* or Dormice, beautiful soft-furred, bushy-tailed little animals, inhabiting Europe, North Asia, and Africa, of which one small species, the Common Dormouse, *Muscardinus avellanarius* (**775**), is a native of England.

The *Muridæ*, or Rats and Mice, of which may be mentioned [Case 33.] the Gerbilles of India and Africa, *Gerbillus* or *Tatera* (**794–796**), and allied genera with elongated hind-feet, on which they jump like kangaroos; the Rats and Mice of the Old World (*Murinæ*), and the Hamsters and American Vesper-Mice (*Cricetinæ*); the Voles (*Microtus*, or, as they have been commonly called, *Arvicola*), whose best-known members are the common English Field-Mouse, *M. agrestis*, and the Water-Rat, *M. amphibius*, both of which are shown in the British Saloon; and their near relative the North American Musquash, *Fiber zibethicus* (**873**), a beautiful example of which is exhibited in case 33. Among the most remarkable members of the *Muridæ* in this case may be mentioned the gigantic Tree-Rats of Luzon in

the Philippines, *Crateromys* (**826**) and *Phlæomys* (**792**) ; and likewise the orange-bellied Australian Water-Rat, *Hydromys chrysogaster* (**791**), which typifies a separate subfamily. There are numerous other genera of the family which must be passed over here, but attention may be directed to specimens of the interesting Lemmings, *Lemmus* (**877—879**), and *Dicrostonyx* (**880**), as well as to the burrowing Mole-Voles, *Ellobius* (**876**), and Zokors, *Siphneus* (**881**), examples of both of which are shown near the bottom of the right side of case 33.

The Bamboo-Rats, *Rhizomys* (**767**), and Mole-Rats, *Spalax* (**770**) and *Bathyergus* (**788**), of Asia and Africa, represent the families *Spalacidæ* and *Bathyergidæ*, and have short tails, thick heavy bodies, and powerful digging claws. Next come the North American Pocket-Gophers (*Geomyidæ*), somewhat similar to the last, but provided with pouches in their cheeks, outside their mouths, often large enough to hold a walnut. Specimens of the typical genus *Geomys* (**777—779**) are exhibited. The Kangaroo-Rats and Pocket-Mice (*Heteromyidæ*), which are also North American, include the genera *Heteromys* (**762**) and *Dipodops* (**784**). Following these are the *Dipodidæ* (or *Jaculidæ*), (case 32), comprising the long-legged and long-tailed Jerboas of North Africa and Asia, specially modified for leaping lightly over a yielding sandy soil, of which there are several generic types, such as *Dipus* or *Jaculus* (**761**), *Alactaga* (**758**), and *Euchoreutes* (**763**).

The Hystricomorpha, or Porcupine tribe, have almost invariably one premolar above and below, a peculiarly twisted lower jaw, variably shaped slits in the palate, generally no process behind the socket of the eye, and separate shin-bones. The Rodents forming this section are very variable both in size and the characters of the skeleton.

This section contains the following families :—The *Pedetidæ*, [Case 34.] represented by the Springhaas, or so-called Jumping Hare, *Pedetes caffer* (**910**), of Africa. The *Octodontidæ* (case 34), with 17 or 18 genera, nearly all confined to South America, of which the best known is the aquatic Coypu, *Myocastor coypus* (**913**), whose habits are similar to those of the Water-Rat, and whose fur is thick and soft, and of considerable value. The Porcupines, found

both in the Old and New Worlds, are all covered with stout variegated spines, although in some of the species these are hidden in the long thick hair. Of the Old-World Porcupines, *Hystricidæ*, the Porcupine of Southern Europe, *Hystrix cristata* (**921**), is now becoming very rare, but several closely allied species are common in India and the Malay Archipelago. They feed on fruit, [Case 34.] bark, and roots, and live in burrows of their own construction. The American Porcupines, *Erithizontidæ*, are typified by the Canadian Porcupine, *Erithizon dorsatus* (**929**), but also include the South-American Tree-Porcupines, *Synetheres*, or *Coendou* (**928**), etc., which are wholly arboreal and have long prehensile tails. The Chinchillas and Viscachas (*Chinchillidæ*), celebrated for their beautiful soft fur, include *Chinchilla* (**905**), *Lagidium* (**906**), and *Lagostomus* (**904**). The Agutis, *Dasyprocta* (**940—945**), and Pacas, *Cœlogenys* (**946**), represent the *Dasyproctidæ*; the Cavies, [Case 35.] *Cavia* (**934—939**), to which belong the little animals known as

Fig. 34.

Skull of the Porcupine. The outer part of the bone of the left side of the lower jaw has been removed to show the whole length of the incisor tooth.

i, incisor teeth; *pm*, premolars; *m*, molars.

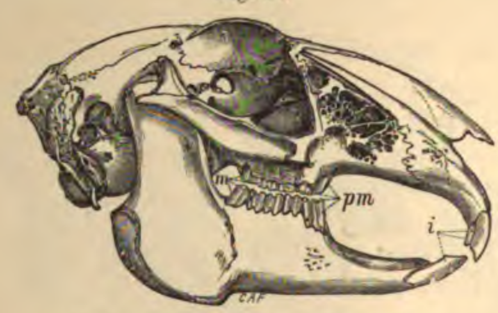
Guinea-pigs, together with the Maras, *Dolichotis* (**931—933**), and the Capybara, *Hydrochœrus capybara* (**947**), by far the largest of the living representatives of the order, constitute the *Caviidæ*. The Capybara in habits is somewhat similar to the Hippopotamus, being thoroughly aquatic, and feeding on water-weeds, grass,

and other vegetable substances. The last three families are restricted to South America.

[Cases 34 & 35.] It may be added that in the true Porcupines (*Hystrix*) the facial portion of the skull (fig. 34) is enormously expanded; while in the Pacas the cheek-arches of the skull are greatly inflated and swollen for the purpose of protecting a pouch which opens into the mouth. The Capybara or Carpincho, in addition to its size, is noticeable for the extreme complexity of the last molar tooth in each jaw.

The second suborder of Rodents, Duplicidentata, distinguished by possessing two pairs of incisors in the upper jaw, consists only of the Hares and Rabbits (*Lepus*) and the Pikas (*Ochotona*), animals far less specialized for gnawing than the other Rodents, and showing, in some respects, the links by which the order is related to other Mammals. Their chief peculiarity is that some of

Fig. 35.



Skull of the Hare (*Lepus europæus*).
i, incisors; *pm*, premolars; *m*, molars.

the bones of their skulls are singularly imperfect, consisting in parts merely of a sort of bony network, especially in the neighbourhood of the nose-chamber (fig. 35). They possess processes behind the sockets of the eye, very large slits in the palate, and united shin-bones.

Lepus contains many species, all on the whole very much alike, of which the three British representatives, the Common Hare, *Lepus europæus* (**960**), the Alpine or Varying Hare, *L. timidus* (**954**), found both in the Highlands of Scotland and in Ireland, and the

Rabbit, *L.* [*Oryctolagus*] *cuniculus* (**961**) are well-known examples. *Ochotona* (**968—970**) consists only of about a dozen species; they are short-eared little animals, known as Pikas or Calling-Hares, from the peculiar piping sound they make. They resemble Guinea-pigs in their external appearance, and are natives of Northern and Central Asia and North America.

Order VI. UNGULATA.

The Hoofed Mammals constituting this group are referred to in a separate Guide, and need not therefore be mentioned in this place.

Order VII. SIRENIA, or SEA-COWS.

(Fossil Mammal Gallery, Geological Department.)

The members of this order differ strikingly in structure from all the foregoing, on account of their aquatic habits and want of hind-limbs. They have rounded heads, very small eyes, no external ears, a pair of fore-flippers, capable of being moved in all directions, no hind-limbs, and broad flattened tails, placed horizontally; while the skin is thick and nearly hairless, the lips alone being covered with stiff bristles.

Most of their bones are extremely dense and heavy, especially the ribs; of the hind-limbs two rudimentary pelvic bones, but no trace of true limb-bones, remain in the existing species. The earlier tail-vertebræ have well-marked chevron-bones attached to their lower surfaces; and in one genus (*Manatus*) there are only six cervical vertebræ, one of the few exceptions to the general Mammalian number of seven. The fore-limbs are developed into flat flippers, not showing externally any trace of fingers.

The skull is of peculiar shape and structure, the front part of both jaws being bent downwards nearly vertically. The molars are either absent, or simple square teeth with transverse ridges, suitable for chewing water-weeds and other vegetable substances. The opening of the nose, as in the Elephants, is placed far back on the upper surface of the skull.

Of the living representatives of the group, the Manatees (*Manatus*) have about twenty molars on each side, of which

six or eight are present at any one time. The muzzle is but little bent downwards; the tail is depressed and rounded, with its hind edge forming a semicircle; and there are rudimentary nails on the flippers. The Manatees, so called from their using their flippers to a slight extent as hands (*manus*), are natives of the rivers and shores of Eastern America and Western Africa within the tropics, never straying far out to sea, but yet unable to go on land, their whole lives being passed in the water. There are three species, namely the African Manatee (*M. senegalensis*), the American *M. americanus*, and the Amazonian *M. inunguis*.

Stuffed specimens and skeletons of *Manatus inunguis* and *M. americanus* are placed in the cases.

The Dugongs, *Halicore*, represent a second genus, characterized by the possession of two tusk-like incisors, and five or six molars on each side; the snout being bent nearly vertically downwards, while there are no nails on the flippers; and the tail is broad, with the hind edge nearly straight, somewhat as in Whales. Dugongs inhabit the coasts of the Indian Ocean, from the Red Sea to Australia, living in shallow waters, and feeding, like Manatees, on sea- and river-weeds, but being on the whole more marine in their habits, and taking more readily to deep water.

Three species have been distinguished, namely—*Halicore tabernaculi*, the Red-Sea Dugong, *H. dugong*, the Indian, and *H. australis*, the Australian species. A stuffed specimen of the Red-Sea Dugong and a skeleton of the Indian species, as well as skulls, are exhibited.

The Northern Sea-Cow (*Rhytina gigas*), which formerly inhabited the shores of the islands in the neighbourhood of Bering Strait and Alaska in numbers, represents a genus entirely without teeth, their place being taken by rough horny plates; snout moderately bent downwards; flippers short; tail with two lateral flukes. The capture of this huge animal was so easy that the process of extermination was accomplished within a short period after its discovery, towards the end of the eighteenth century. Before its extermination, a German naturalist in the Russian service, Steller, published an account of its anatomy and habits; so that it is nearly as well known as its living allies. Many of its remains were

discovered during the voyage of the 'Vega' in the region where it lived. A nearly perfect skeleton from Bering Island is placed in the case.

The Northern Sea-Cow was more than twice as large as either the Dugongs or Manatees, attaining a length of about 25 feet; but its habits were similar.

Fossil Sirenians are known as far back as the Middle Eocene period, the *Eotherium ægyptiacum* having been found in Egyptian deposits of that age. In later times the members of this order, such as *Halitherium*, were abundant in European seas, and their remains occur fossil in considerable numbers in Germany, France, and Italy, as well as in the bone-bed of the English Red Crag. Remains of many representatives of these fossil Sea-Cows are exhibited.

Order VIII. CETACEA, or WHALES and DOLPHINS.
(Ground-Floor.)

The large size of so many members of this group renders it impossible that they can be exhibited in their proper serial position, and they are consequently placed in a special annexe, leading out from the bird gallery on the ground-floor. Moreover, since it is almost impracticable to preserve the skins of the larger Whales, owing to the oil with which they are saturated, the exhibition of these animals is effected by means of models, casts, skeletons, and sketches.

The order CETACEA is one of the best marked and most natural of all the larger groups into which the class Mammalia is divided. In all essential characters, by which Mammals are distinguished from the other vertebrated animals, such as possessing warm blood, breathing air by means of lungs, bringing forth their young alive, and nourishing them for a time with milk, they agree with the other members of their class; the striking external differences being all in relation to their adaptation to an entirely aquatic mode of life. Their external form is fish-like, the body being spindle-shaped, passing into the head usually without a distinct neck, and tapering behind gradually towards the extremity of the tail, which is provided with a pair of lateral, pointed expansions called "flukes," forming a horizontally-placed triangular propelling

organ, notched in the middle line behind, with which the animals drive themselves through the water.

The head is generally large, in some species attaining more than one third the entire length of the animal, and the mouth is wide, and bounded by stiff immobile lips. The fore-limbs are reduced to the condition of flattened paddles, encased in skin showing no external sign of division into arm, fore-arm, and hand, or of separate fingers, and without any trace of nails. No signs of hind-limbs are visible externally. The general surface of the skin is smooth, glistening, and devoid of hair, although in most species there are a few fine bristles in the neighbourhood of the mouth, which either remain throughout life or are found only in the young state. Immediately beneath the skin is a thick layer of fat, held together by a mesh of fibrous tissue, constituting the "blubber," which serves the purpose of the hairy covering of other Mammals in retaining the heat of the body. In most species there is a fin, more or less triangular in shape, composed only of skin and fibrous tissue, near the middle of the back, which assists in keeping the animal upright when swimming. The eye is small; and the aperture of the ear minute, and without vestige of a pinna or conch. The nostrils, generally called "blowholes," open separately, or by a single valve-like aperture, placed (except in the Sperm-Whale) not at the extremity of the snout, but near the top of the head.

The bones generally are spongy in texture, their cavities being filled with oil. In the back-bone the region of the neck is remarkably short and incapable of motion, and the vertebræ, originally seven in number, as in other Mammals, are in many species more or less fused into a solid mass. None of the hinder vertebræ of the body are united together to form a "sacrum," or to join the pelvis, as in Mammals in which the hind-limbs are fully developed. The vertebræ of the loins and tail are numerous, large, and capable of free motion. Beneath the latter are large V-shaped "chevron-bones" which project downwards, and give increased surface for the attachment of the muscles which move the tail. There are no bones supporting the lateral "flukes" of the tail or the back-fin.

The skull is modified in a peculiar manner; the brain-case being

short, high, and broad, almost spherical in fact. The nostrils open upwards, immediately in front of the brain-case, and before them is a more or less horizontally prolonged beak, extending forwards to form the upper jaw or roof of the mouth. There are no collar-bones (clavicles). The upper arm-bone or humerus is freely movable on the scapula, or blade-bone, at the shoulder-joint; but beyond this the articulations of the limb are imperfect, flattened ends of the bones coming in contact with each other, with fibrous tissue interposed, allowing of scarcely any motion. The two bones of the fore-arm (radius and ulna) are distinct and much flattened, as are the bones of the hand. There are usually five fingers, though sometimes the first, or the one corresponding to the thumb, is wanting. The pelvis, or hip-bone, is represented by a pair of elongated slender bones, suspended below, and at some distance from, the vertebral column, in the region of the loins. Since these bones in the living animal are concealed in the flesh and not connected with the spinal column, they are often lost in preparing skeletons. To the outer side of these, in some Whales, are attached small bones which represent the bones of the limb proper. In the skeleton of the Common Rorqual (*Balænoptera musculus*) a little nodule of bone, scarcely larger than a walnut, has been preserved; it is the rudiment of the thigh-bone or femur, and the only trace of a hind-limb which this gigantic animal possesses. The existence of these rudimentary structures has an important bearing upon the origin and past history of Whales and their relationship to other Mammals.

Cetaceans abound in all seas, and some species are inhabitants of the larger rivers of South America and Asia. Their organization necessitates passing their life entirely in the water, as on land they are absolutely helpless. They have, however, to rise frequently to the surface in order to breathe; and, in relation to the constant upward and downward movement in the water thus necessitated, their principal instrument of motion, the tail, is expanded horizontally, unlike that of a Fish, whose movements are mainly in straightforward or lateral directions. The position of the nostrils on the highest part of the head is important for this mode of life, as it is the only part of the body the exposure of which above the surface is absolutely necessary. The "spouting,"

or properly "blowing," of the Whale is nothing more than the ordinary act of breathing, performed at longer intervals than is the case with land animals. The moment the Whale rises to the surface it forcibly expels from its lungs the air taken in at the last inspiration, which of course is heated and charged with water-vapour. This, rapidly condensing in the cold atmosphere in which the phenomenon is often observed, forms a column of steam or spray, which has been mistaken for water. Frequently, however, it happens, especially when the surface of the ocean is agitated into waves, that the animal commences to "blow" before the nostril has cleared the top of the water, some of which may thus be driven upwards with the blast. In hunting Whales the harpoon often pierces the lungs or air-passages, and then fountains of blood may be forced high in the air through the blowholes, as commonly depicted in scenes of Arctic adventure; but this is nothing more (allowance being made for the Whale's peculiar mode of breathing) than what always follows severe wounds of the lungs of other Mammals.

Whales and Dolphins prey upon living animal food; but the Killer-Whales, *Orca*, alone eat other warm-blooded animals, as Seals, and even members of their own order, large and small. Many feed on fish, others on small floating crustaceans, minute molluscs and jelly-fish; while the principal food of many is constituted by various species of cuttlefishes, especially squid, which abound in some seas, where they form almost the entire support of some of the largest members of the order.

In size the members of the group vary much, some of the smaller Dolphins scarcely exceeding four feet in length, while Whales are the most colossal of all animals. It is true that statements of their bulk are exaggerated, but even when reduced to their actual dimensions some of the existing Whales exceed in bulk any animal of present or past times of which we have any certain evidence.

With some exceptions, Whales and Dolphins are timid, inoffensive animals, active in their movements, and affectionate in disposition towards one another. This is especially the case with regard to the conduct of the mother towards her young, of which there is usually but one, and at most two, at a time. They are generally gregarious, swimming in herds or "schools" sometimes amounting to hundreds in number, though some species are met with singly or in pairs.

The great commercial value of the oil which all the Cetacea yield, and the special products of certain species, such as whalebone, spermaceti, &c., cause them to be subject to unremitting persecution, which has greatly diminished their numbers, and threatens some with extermination.

The existing members of the order are separated into two suborders, showing important structural differences. These are the Toothed Whales or Odontoceti, and the Whalebone-Whales or Mystacoceti.

Among other characters, the Toothed Whales have no whalebone, but always possess teeth, which are generally numerous, although sometimes few and rudimentary. The upper portion of the skull is more or less unsymmetrical, and there is an organ of smell. The two halves of the lower jaw come in contact in front by a flat surface of variable length, constituting a true symphysis. Several pairs of ribs are connected with the elongated breast-bone, or sternum, by means of cartilages, which are often ossified. The blowhole is single, the two nostrils uniting before they reach the surface, usually in the form of a transverse crescent-shaped aperture on the top of the head.

The members of the family *Physeteridæ* are distinguished by several common characters of the skull and vertebral column, by never having functional teeth in the upper jaw, and by their rib-cartilages never becoming ossified.

The most interesting member of this family is the Sperm-Whale or Cachalot (*Physeter macrocephalus*), of which a model has been constructed on the skeleton of a specimen cast ashore on the coast of Caithness, near Thurso, in June 1863 (fig. 36). It is 54 feet long (measured in a straight line); this being about the average length of a full-grown specimen of this animal, notwithstanding statements as to a length of 80 or 100 feet being attained. Cachalots feed chiefly on cuttlefishes, and are some of the most extensively distributed of Cetaceans, being met with, usually in herds or "schools," in almost all tropical or subtropical seas, and occurring occasionally even so far north as Shetland. The oil contained in the great cavity of the skull yields "spermaceti," used in the manufacture of candles and of ointments, and the thick covering of blubber enveloping the body produces sperm-oil. Hence this animal has long been the subject of a

Fig. 36.

The Sperm-Whale or Cachalot (*Physeter macrocephalus*).

Skeleton and outline. *b*, nostril or blowhole; *p*, rudimentary pelvic bone.

regular chase, by which its numbers have been greatly diminished. The substance called "ambergris," largely used in perfumery, is a concretion formed in the intestines of the Sperm-Whale, but generally found floating on the surface of the seas which it inhabits; its genuineness is attested by the presence of fragments of the horny beaks of the cephalopods on which the Whales feed. A specimen is exhibited in a small glass case at the north-west corner of the room.

Nearly allied to the Sperm-Whale, but of much smaller size, is the Lesser Sperm-Whale, *Cogia breviceps*; the skeleton exhibited being from the neighbourhood of Sydney.

The Beaked Whales, or *Ziphiinæ*, a section of the *Physeteridæ*, resemble Sperm-Whales in having no upper teeth (or if present rudimentary and attached only to the gum), but differ in that the lower teeth, instead of being numerous, are reduced to one or, rarely, two pairs. These are situated either quite at the front extremity of the jaw, as in *Ziphius* and *Hyperoödon*, or near the middle, as in *Mesoplodon*. In one species of the last-named genus (*M. layardi*), from the South Seas, these teeth are much elongated and flattened, and in old animals (as in the skull exhibited in the table-case) curve round and meet over the upper jaw, so as almost to prevent the mouth from opening. This disposition of the teeth has been found in so many individuals that it must be normal, and not, as at first thought, an accidental peculiarity, though it is difficult to understand how it is consistent with the animal obtaining its food.

The best-known animal of this group found in the British seas is the Bottle-nose (*Hyperoödon rostratus*). In the young of both sexes the bony crests on the upper surface of the skull are small, and in females they remain of medium size, but in males gradually increase as age advances. This Whale is an inhabitant of the northern Atlantic, and, as it yields both spermaceti and oil equal in value to that of the Sperm-Whale, it is now the object of a regular "fishery."

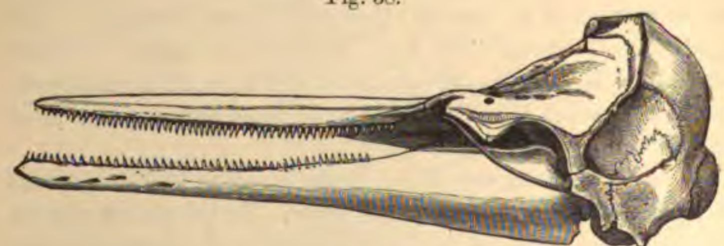
On the left side of the vestibule leading into the building is a case containing the Freshwater Dolphins, or *Platanistidæ*. Among these are a stuffed specimen, skeleton, and several skulls of the Dolphin of the rivers of India (*Platanista gangetica*), which has never been found in the open sea, but is extensively distributed

throughout nearly the whole of the river-systems, not only of the Ganges, but of the Brahmaputra and Indus, ascending as high as the depth of water permits. The eyes are exceedingly small and imperfect in structure; and the creature appears to be quite blind. It feeds on small fish and crustaceans, which it gropes for with its long snout in the muddy water at the bottom of the rivers. The blowhole, as may be seen in the stuffed specimen, is a single slit, placed lengthwise, and not transverse to the head as in most Dolphins, and the back-fin is merely a low ridge. The skull has on the upper surface a pair of large, compressed, bony crests,

Fig. 37.

The Dolphin (*Delphinus delphis*).

Fig. 38.



Skull of the Dolphin.

overarching the aperture of the nostrils and base of the beak, and nearly meeting in the middle line above. The jaws are exceedingly long and narrow, and armed with numerous slender, pointed teeth, which undergo curious changes of form as life advances, the cast of the beak of a very old individual exhibiting the form assumed by the teeth at this stage.

In the same case are the skeleton and some skulls of another

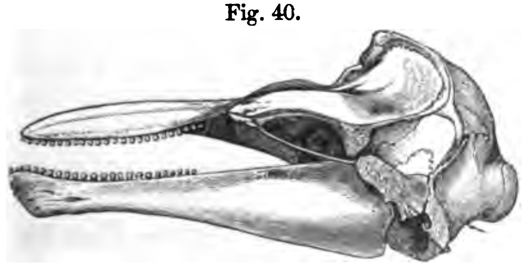
freshwater Dolphin, *Inia geoffrensis,* from the Upper Amazon and its tributary streams, and also of a species, *Pontoporia blainvillii,* from the estuary of the Rio de la Plata, of very small size, with long and slender jaws and the most numerous teeth of any Mammal, sometimes as many as 60 on each side of each jaw, or 240 in all. Of the latter species a coloured model is also exhibited.

The *Delphinidæ* form a numerous group, including the species commonly called Dolphins and Porpoises, although some of the larger members are also dignified by the name of Whales.

Fig. 39.

The Porpoise (*Phocæna communis*).

Fig. 40.



Skull of the Porpoise.

Skeletons of some of the species are exhibited, and also stuffed specimens or papier-maché models of others; and a series of casts of heads is affixed to the walls.

Among the more interesting forms, reference may be made to the true Dolphins (*Delphinus*), which are found in considerable abundance in all seas, and are some of the smaller members of the order, none exceeding 10 feet in length. Their food is chiefly fish, for the capture of which their long, pointed beaks, armed with numerous sharp teeth, are well adapted; but some also devour crustaceans and shell-fish. They are mostly sociable, and

the agility and grace of their movements are constant themes of admiration.

The name *Delphinus* is now restricted to the Common Dolphin of the Mediterranean, *D. delphis,* and its immediate allies, which is met with, though not frequently, on the English coast. There are casts of the heads of a pair of this species and also of the allied Bottlenose Dolphin, *Tursiops tursio,* with no teeth in the upper, and but few in the lower jaw, from the Atlantic coast of North America.

Risso's Dolphin, *Grampus griseus,* which is about 13 feet long, and of very variable colour, is occasionally met with off our coasts. On the wall are coloured casts of the heads of an adult and young from North America.

The Black-fish, *Globicephalus melas,* has also few and small teeth, but these are present in both jaws. It is characterized by the rounded form of the head and the very long and narrow flippers. This species, also known as the Pilot-Whale, Ca'ing-Whale, or Grindhval by the Faroe islanders, attains a length of 20 feet, and is of nearly uniform black, except the middle of the under surface, which is lighter. It is very gregarious, and mild and inoffensive in disposition, feeding on cuttle-fishes. This sociable disposition constantly leads to the destruction of these Whales, as, when attacked, they rush together and blindly follow the leaders of the herd. In this way many hundreds at a time are frequently driven ashore and killed, when a herd enters one of the bays or fiords of the Faroe or Shetland Islands. They are widely distributed; specimens from New Zealand being indistinguishable from those taken in the northern seas. The species is represented by a model and a skeleton.

The Porpoise, *Phocæna communis,* is the best-known and most frequent Cetacean on our coasts. Together with its immediate allies, it differs from other *Delphinidæ* in the form of the teeth, which, instead of being conical and pointed, have compressed spade-shaped crowns. Its external form is well seen in the coloured model of an American specimen. A closely-allied form, *Neomeris,* or *Neophocæna, phocænoides,* differing mainly in the absence of a back-fin, is common off the coast of Bombay, and has been met with in other parts of the Indian Ocean and near Japan. The

specimen exhibited was captured in the Yang-tse-kiang river, nearly a thousand miles from the sea.

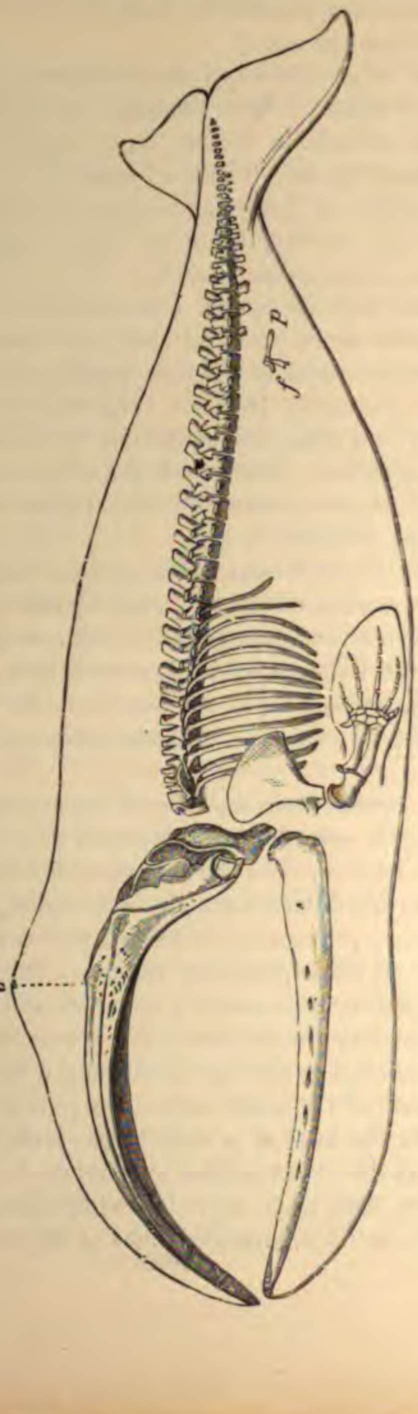
Very different in structure and habits from the last is the "Grampus" or "Killer," *Orca gladiator*, a powerful species with numerous formidable teeth, high, pointed back-fin, and broad rounded flippers. "Killers" are found in almost all seas, from Greenland to Tasmania, and are distinguished from their allies by their ferocity, being the only Cetaceans which habitually prey on warm-blooded animals; for though fish form part of their food, they also attack and devour Seals, Porpoises, Dolphins, and combine in packs to hunt and destroy full-sized Whales. A life-sized model of a female caught at the mouth of the Humber, in November 1885, is exhibited near the north end of the gallery, and alongside the skeleton of this same female.

The Irawadi Dolphin, *Orcella fluminalis*, is a small species found in the Irawadi river, from 300 to 900 miles from the sea, of which a skeleton is exhibited.

The Beluga, or White Whale, *Delphinapterus leucas*, so called from its almost pure white colour, and about 12 feet long, is abundant in the Arctic seas, and extends as far south on the American coast as the river St. Lawrence, which it ascends for a considerable distance. On rare occasions it has been seen on the coast of Scotland. It has no back-fin. A model made on the skeleton is exhibited.

The Narwhal, or Sea-Unicorn, *Monodon monoceros*, resembles the Beluga closely in everything but its teeth, as will be seen by comparing their skeletons. The Narwhal has only two teeth in the adult state, both of which lie horizontally in the upper jaw. In the female these remain permanently concealed within the bones of the jaw, so that this sex is practically toothless; but in the male, while the right tooth remains similarly concealed and abortive (as shown in the skeleton by removal of part of the bone which covered it), the left is immensely developed, attaining a length equal to more than half that of the entire animal, projecting horizontally from the head in the form of a cylindrical or slightly tapering pointed tusk, with the surface marked by spiral grooves and ridges. In very rare cases both teeth are fully developed, as in the skull exhibited near the skeleton. Narwhals inhabit the Arctic regions,

Fig. 41.



The Greenland Right-Whale (*Balæna mysticetus*).

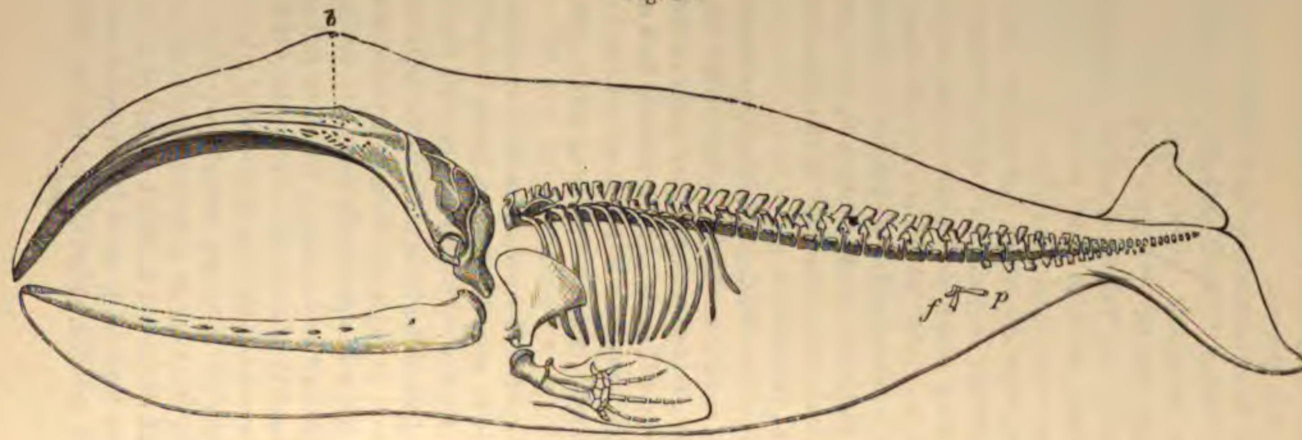
Skeleton and outline: *b*, position of nostrils or blowholes; *p*, pelvic or hip-bone; *f*, rudimentary femur or thigh-bone.

where they are tolerably abundant and gregarious, and feed on various cuttlefishes, small fish, and crustaceans. The use to which they put the tusk (often spoken of as the "horn") is not known. Three separate tusks are exhibited on the wall to the right of the entrance.

Although the Whalebone Whales (Mystacoceti) have rudimentary teeth developed at an early period of life, these soon disappear, and their place is occupied in the upper jaw by the "whale-bone," which consists of a series of flattened, horny plates, between three and four hundred in number on each side of the mouth, placed transversely to the long axis of the latter, with very small interspaces. Each plate or blade is somewhat triangular in form with the base attached to the palate, and the point hanging downwards. The outer edge of the blade is hard and smooth, but the inner edge and tip fray out into long bristly fibres, so that the roof of the Whale's mouth looks as if covered with hair. The blades are longest near the middle of the series, and gradually diminish towards the front and back of the mouth. Whalebone (as seen in various specimens in the skulls and on the walls) varies much in colour in different species of Whales. In some it is almost jet-black, in others slate-colour, horn-colour, yellow, or even creamy white. In some the blades are variegated with longitudinal stripes of different hues. It differs also greatly in other respects, being short, thick, coarse, and stiff in some, and greatly elongated and highly elastic in those species (as the Greenland Right-Whale, *Balæna mysticetus*) in which it attains its fullest development. Its use is to strain the water from the small marine molluscs, crustaceans, or fish upon which these Whales subsist. In feeding, they fill the immense mouth with water containing shoals of these small creatures, and then, on closing the jaws and raising the tongue so as to diminish the cavity of the mouth, the water streams out through the narrow intervals between the hairy fringe of the whalebone-blades, and escapes through the lips, leaving the living prey to be swallowed.

Among other characters by which the Whalebone Whales are distinguished from the Toothed Whales, may be mentioned:—The external openings of the nostrils are distinct from each other, and consist of a pair of longitudinal slits on the top of the head; the two sides of the upper part of the skull are symmetrically

Fig. 41.



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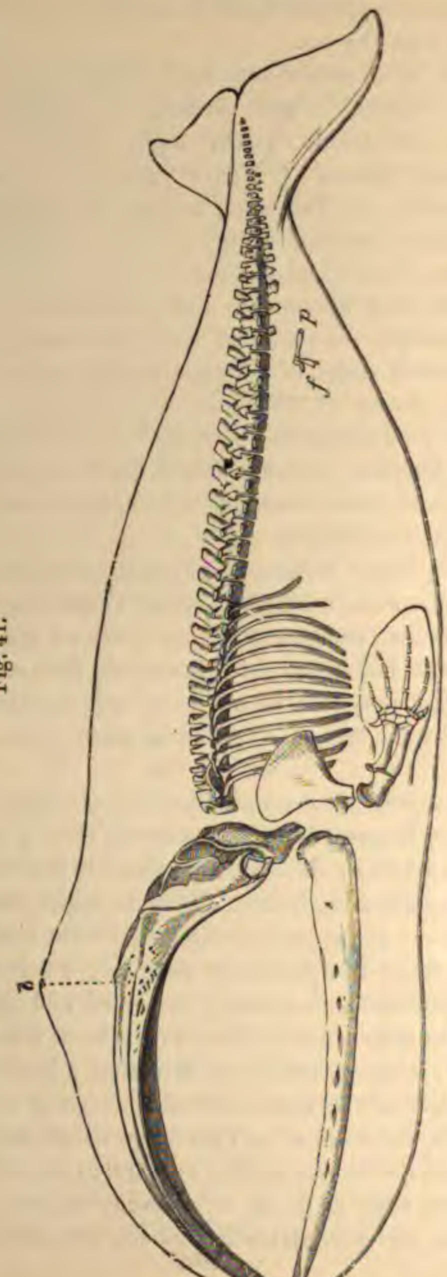

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developed; the organ of smell, though small, is formed as in other Mammals. The two halves of the lower jaw are curved outwards in the middle, and loosely connected both to the skull behind and to each other in front by fibrous bands. When the mouth is open in feeding, they fall outwards, widening the capacious bag formed by the dilatable skin of the throat (the power of distention of which is aided in many species by a series of longitudinal folds), which may be compared to the pouch under the beak of the Pelican. By their rotation upwards and inwards when the mouth is closed, they are brought close to the upper jaw. The sternum, or breast-bone, is composed of a single piece, often taking the form of a cross, and articulating only with a single pair of ribs. There are never any bony ribs joining the breast-bone.

In the Right-Whales, *Balæna,* the skin of the throat is smooth, and not furrowed. There is no back-fin. The neck-vertebræ are united into a single mass; and the fore-limb is broad and short, with five fingers. The head is very large, and the whalebone very long and narrow, highly elastic and black, as seen in the specimens on the wall at the north-west corner of the gallery.

This genus contains the well-known Greenland Right-Whale (*Balæna mysticetus*) of the Arctic seas, which yields whalebone of the greatest value and train-oil. As it never leaves the ice, it is not an inhabitant of the seas round our islands. It used to be hunted every summer in Baffin Bay and the seas round Spitzbergen by ships fitted out at Dundee and Peterhead. The Museum at present only possesses a skull of this most interesting animal; but a carefully executed coloured model, on the scale of one inch to the foot, presented by Captain D. Gray, gives a good idea of its external appearance.

Besides the Greenland Right-Whale there are other members of the same genus, distinguished by having heads somewhat smaller in proportion to the body, with shorter whalebone and a larger number of vertebræ. These inhabit the temperate seas of both northern and southern hemispheres; and although divided into species, in accordance with their geographical distribution, such as *B. biscayensis* of the North Atlantic, *B. japonica* of the North Pacific, *B. australis* of the South Atlantic, and *B. antipodarum* of the South Pacific—their distinctive differences are comparatively slight. The first-named was the Whale

formerly regularly hunted by whalers from the Basque seaports of France and Spain, and the main source of supply of whalebone and oil until the discovery of the Greenland Whale in the seventeenth century. It became extremely rare, but owing to the diversion of the whalers' attention to the larger and more profitable Arctic species, it has again become rather more numerous. The skeleton of a male specimen obtained from the coast of Iceland forms the basis for a half-model of this species. A mass of united neck-vertebræ, dredged from the bottom of the sea near Bridport, in 1853, probably also belongs to this species. None of the Right-Whales exceed 50 feet in length.

The cast of the head of the Pigmy Whale, *Neobalæna australis*, of New Zealand, Australia, and South America, is placed on the north wall of the building, and a skeleton near by. Besides peculiarities in the form of its bones, this species, which does not exceed 25 feet in length, is distinguished by its very long, slender, elastic whalebone, which is nearly white in colour, with a dark external border.

The Grey Whale of the North Pacific, *Rhachianectes glaucus*, of which no specimen is at present exhibited, combines the small head, elongated form, and narrow flippers of the Rorquals with the smooth throat and absence of the back-fin of the Right-Whales. It is an exceedingly rare species. The whalebone is short and yellow in colour. The two front ribs are fused together, and the sternum is unusually long and narrow.

Another group is represented by the Humpback Whale (*Megaptera bŏops*), a species likewise at present unrepresented in the exhibited series. In this Whale the head is of moderate size, and the whalebone-plates are short and broad, the neck-vertebræ being free. The most conspicuous distinguishing character is the immense length of the flipper, about one fourth of that of the entire animal. It is on account of the low rounded form of the back-fin, that these Whales are called "Humpbacks" by the whalers. They have a wide geographical range.

The various species of Rorquals, Fin-Whales, Fin-backs, Finners or Razor-backs, as they are variously called, some of which are found in almost every sea, constitute the genus *Balænoptera*, characterized by the comparatively small, flat, and pointed head, with the throat marked by longitudinal pleats capable of distention

Fig. 42.

The Common Rorqual or Fin-Whale.

Skeleton and outline: *b*, position of blowholes; *p*, pelvic bone.

to form a pouch, low back-fin, short, narrow, and pointed flippers, with but four fingers, coarse and short whalebone, and separate neck-vertebræ.

Rorquals are "clipper-built" Whales, adapted for a high rate of speed. The largest is Sibbald's Rorqual (*B. sibbaldi*), which grows to about 80 feet, and is common in the seas between Scotland and Norway. Almost of equally colossal proportions is the Common Rorqual (*B. musculus*), found throughout the North Atlantic and Mediterranean, and often stranded on the English coasts. The complete skeleton of a full-grown animal, 68 feet long measured in a straight line, from the Moray Frith, Scotland, where it was captured in 1882, shows the osteological characters of this group of Whales, even to the small pelvic bone and rudimentary nodule representing the femur or thigh-bone. Upon this skeleton has been modelled one half of the body to exhibit the external form. The whalebone is in place in the mouth, and the flukes of the tail and the dorsal fin are also preserved, and suspended on the wall behind the specimen.

Balænoptera borealis, Rudolphi's Rorqual, is a species of inferior size to the last, also commonly stranded in Great Britain.

In a table-case near the large Rorqual are exhibited the curious ear-bones of various Whalebone Whales, together with a few of those of the Toothed Group. Each genus, if not species, can readily be distinguished by the form of its ear-bones.

Order IX. EDENTATA, or Sloths, Anteaters, and Armadillos.

(Lower Gallery, Cases 67* and 68.)

The Edentates as represented by the Sloths, Anteaters, and Armadillos of South and Central America and the Pangolins and Ant-Bears of the Old World are characterized by the incomplete state of their dentition, teeth in many cases being absent, while when present they are always composed of dentine and cement only (without enamel), and never form roots. As a rule, the teeth are of a simple type, more or less completely alike, absent from the front of the jaws, and without milk-predecessors.

[Case 68.] Of the American members of the groups, the Sloths (*Bradypodidæ*) are characterized by their short round heads, long fore-legs, toes fastened together by skin and terminating in long curved claws, and the coat of coarse brittle hairs. They are entirely tailless. Sloths pass their whole existence on trees, hanging by their long and powerful claws to the underside of the branches, never descending to the ground unless compelled, and feeding on leaves and young twigs, for the mastication of which their few and simple teeth are sufficiently well suited. Inhabiting the forests of Tropical America, they are slow in their movements, but by no means so helpless as is often supposed, although they escape their enemies less by their own exertions than by the difficulty with which they are distinguished from the branches to which they cling. This resemblance is increased by the growth of an alga in the grooves of the coarse hair (as illustrated in the case), which communicates a green tinge to the entire coat.

Sloths have five teeth above and four below. The neck-vertebræ, which in all other Mammals, except the Manatees, are 7 in number, amount to no less than 9 in the Three-toed Sloths, *Bradypus* (**1383**), while in certain of the Two-toed Sloths, *Cholœpus* (**1384**) there are only 6. The pelvis is remarkable for being united to an unusually long portion of the back-bone. In old animals most of the bones of the wrist and ankle joints become united together. In addition to the difference in the number of their claws, the Three-toed Sloths, or Unaus, and the Ais, or Two-toed Sloths, are distinguished by the different shape and proportions of their teeth,—those of the former being small, of equal size, and the upper ones placed opposite the lower, so that they wear down nearly flat; while in the latter the first tooth in each jaw forms a sort of canine, twice as long as any of the others, and as the teeth are placed alternately in the two jaws, they are worn down into wedge-shaped crowns. Skeletons and skulls of both genera are placed in the case.

Intermediate to a certain extent between the Sloths and Ant-eaters are certain huge fossil animals, found in the Tertiary deposits of South America, of which the best known is the Great Ground-Sloth (*Megatherium americanum*, **1385**); a cast of the complete skeleton is exhibited in the palæontological gallery,

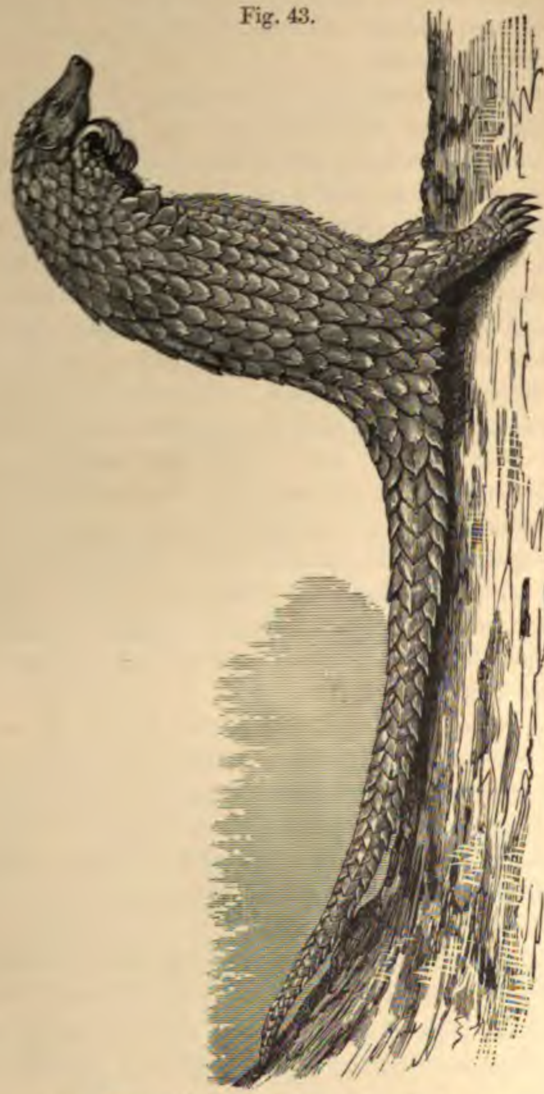
and one tooth in case 68 of the lower Mammal gallery. *Mylodon* is an allied genus. In the earlier Tertiaries of Patagonia the species are much smaller; and one kind has certainly existed within the human period.

[Case 68.] The Anteaters (*Myrmecophagidæ*) have narrow heads with long snouts, to accommodate their enormously long worm-like tongues; their tails are well developed, and in some species prehensile, their toes separate from each other, as in ordinary Mammals, and the third on the fore-foot is provided with a huge digging claw. Like the Sloths, they are all natives of Tropical America. The Great Anteater, *Myrmecophaga jubata* (**1388**), is about four feet in length and has a long black mane along its back, a thick bushy tail, and a long narrow head, about a foot in length, the greater part of which is made up by the maxillary bones. There are no zygomatic, or cheek, arches to the skull, little biting-power being needed; the collar-bones, or clavicles, are exceedingly rudimentary. This Anteater is terrestrial in its habits, and feeds entirely on ants, which it catches with its long sticky tongue, after having torn open their nests with its powerful claws. Much smaller are the Tamandua, *Tamandua tridactyla* (**1387**), and the Two-toed Anteater, *Cycloturus*, or *Cyclopes, didactylus* (**1386**), the latter being scarcely larger than a Rat. Both lead an entirely arboreal life and have the tail prehensile.

The Armadillos, or *Dasypodidæ*, are remarkable for the thick plates of bone with which their bodies are covered, forming immovable shields across the shoulders and hips, the centre of the back being protected by a greater or less number of transverse bands of plates, joined to each other by flexible skin. The head and tail are also covered by a mosaic of bony plates; but the belly and inner sides of the limbs are clothed only with soft skin. The fore-feet have a variable number of long and powerful claws, but the hind-feet always carry five rather small claws. In all the group teeth are present, generally $\frac{7 \text{ to } 9}{7 \text{ to } 10}=28$ to 38 in number, but in the Giant Armadillo amounting to $\frac{20 \text{ to } 25}{20 \text{ to } 25}=80$ to 100. These teeth are small and simple, with single roots. In the genus *Tatusia* alone a set of double-rooted milk-teeth precedes the simple single-rooted permanent ones, and traces of a milk-

dentition have also been found in *Dasypus*. The second and third,

Fig. 43.



The West-African Pangolin (*Manis tricuspis*).

and often several of the other neck-vertebræ are welded together. The collar-bones, or clavicles, are well developed, and the

whole fore-limb is enormously strengthened to support the huge digging-claws.

The largest species is the Giant Armadillo, *Priodontes gigas* (**1381**), measuring more than two feet in length; while the smallest, rarest, and in many respects the most interesting, is the Pichiciago, or Fairy Armadillo, *Chlamydophorus truncatus* (**1377**), which has the outer shield attached to the hip-bones by peculiar bony processes. It leads an underground life. The Three-banded Armadillos, *Tolypeutes* (**1373—1374**), have the power of rolling themselves up into perfect balls, like Hedgehogs, the head and tail fitting into corresponding notches in the shield. Armadillos are ground-animals, able to burrow in the soil with surprising rapidity, either with the object of escaping danger or in search of their food, which consists of roots, insects, worms, reptiles, and carrion. They are found chiefly in the warmer parts of Central and South America, although a few range southwards into Patagonia.

Fossil Armadillos are numerous in the Tertiary deposits of South America, many belonging to existing genera. The case contains a few bones and illustrations of the extinct South American family *Glyptodontidæ* (**1389—1391**), some of the members of which were of gigantic size, while all had the bony shield solid throughout. Numerous specimens are exhibited in the palæontological gallery.

Of the Old-World Edentates, the Scaly Anteaters, or Pangolins, [Case 67*.] *Manidæ* (**1362—1368**), are characterized by their entire want of teeth, elongated skulls (which are without cheek-arches), slender jaws, and long powerful tails, of which the vertebræ, numbering from 28 to 46, are provided with large chevron-bones. The breast-bone is produced backwards nearly to the pelvis, and the retracting muscles of the tongue are attached to its hinder part. There are no clavicles. Pangolins, with their long scaly bodies and tails, and their short legs, look more like Reptiles than Mammals. Like the Anteaters they are toothless, and likewise live on ants, which they catch with their tongues. The scales may be looked upon as hairs, or rather spines, enormously enlarged and dilated. Their long, strong, and broad tails form part of the protective armour when they coil themselves up into balls like Armadillos, and are used

G 2

as supports in climbing the trunk of a tree. Some species rest themselves on the tail, which is pressed to a trunk, whilst the body is thrown backwards and assumes the appearance of a projecting broken branch, as in *Manis tricuspis* (**1363**, fig. 43). In order to keep their claws sharp, they walk with them closed up against the palms of the feet, the backs only of the toes touching the ground. There are seven species of Pangolins, four African and three Asiatic, the largest of these being the West and Central African Giant Pangolin, *M. gigantea* (**1365**).

[Case 67.] The Ant-Bears, or Aard-varks, *Orycteropus* (**1369**), are natives of Africa, and strikingly different from all other Edentates. They represent a distinct family, the *Orycteropodidæ*, and are distinguished externally by their long, low, hair-covered bodies, long snouts and tongues, large ears, stout powerful tails, and short thick limbs. They have four toes on the front, and five on

Fig. 44.

An Ant-Bear, or Aard-vark (*Orycteropus afer*).

the hind-feet, all modified for digging, their manner of life being very similar to that of the Great Anteater, as they feed chiefly on ants and other small animals. The adult specimen placed in the table-case shows the curious appearance of these animals, which induced the early Dutch settlers in the Cape to compare them to pigs, and to name them Aard-varks, *i. e.* Earth-pigs.

Ant-Bears have $\frac{8 \text{ to } 10}{8}$ teeth, of a peculiar and complex structure, each consisting of a large number of separate parallel tubes, closely packed together. In a transverse section they present an

appearance not unlike that of a piece of cane. These teeth are preceded by a set of minute milk-teeth, remnants of a former functional set, which show indications of a division into different groups, such as premolars and molars. The cheek-arches, or zygomata, are complete, and there are well-developed collar-bones, or clavicles.

The Common Ant-Bear, *Orycteropus afer* (fig. 44), is an animal of about the size of a Pig.

Order X. MARSUPIALIA, or Marsupials.

(Lower Gallery, Cases 69–70.)

This order differs by numerous and important anatomical characters from all the preceding groups; and there is, moreover, a curious parallelism between its members and the former, in that Marsupials include species representative of the herbivorous, carnivorous, and insectivorous types of other Mammals.

The females of most Marsupials possess a pouch of skin on the under part of their bodies, which gives the name to the order. In this pouch the young, which are in a very imperfect condition when born, continue their development, clinging at first firmly to the nipples, and using the pouch for a long time afterwards as a place of refuge until able to take care of themselves. In fact, functionally, the pouch of a Marsupial corresponds to the nest of a bird.

The principal characteristic by which the skeletons of Marsupials differ from those of all the previous orders is the presence of a pair of long slender bones, attached to the front edge of the pelvis. These are known as the "marsupial bones," owing to their proximity to the external pouch *. In their skulls the Marsupials differ from other Mammals by having the angle of the lower jaw much bent inwards, and forming a well-marked internal process. Teeth are always present, and separable into different classes, but, with the exception of one premolar, not preceded by milk-teeth. The incisors are generally unequal in

* They are absent in one genus only, *Thylacinus*, and in some American Opossums.

number in the two jaws, and range from $\frac{2}{2}$ to $\frac{5}{4}$. The dorso-lumbar vertebræ are invariably 19.

[Cases 69 & 69*.] Marsupials are divided primarily into two great groups: in the first, as in the Rodents and Ungulates, the incisors are few in number, but large and powerful, and the canines, at least in the lower jaw, are either entirely absent or small and rudimentary; while the second possess, like the Placental Carnivora, small and numerous incisors and large and sharp canines. The former are called "Diprotodont"† and the latter "Polyprotodont"‡.

To the former group belong Kangaroos, Phalangers or Australian Opossums, and Wombats, which, with but few exceptions, live chiefly upon vegetable food; to the latter, carnivorous both in structure and habits, the American Opossums, Dasyures or Native Cats, and Bandicoots.

The geographical distribution of this order is remarkable, two families out of eight being found in South America, while all the rest are now confined to the Australian region.

The Kangaroo-group, or *Macropodidæ* (cases 69 and 69*) includes herbivorous animals with disproportionately large hind-limbs and long powerful tails, both of which they use in leaping or in assuming an erect position, putting their short fore-feet to the ground only when feeding or walking. Their hind-feet are of very peculiar structure, the great mass of the foot being made up of the much-developed fourth toe, while the first toe, corresponding to our great toe, is entirely absent; and the second and third, although long, are so slender and weak as to be quite useless, and bound up in a common skin to the nails. This structure of the foot is not confined to the Kangaroos, but is also found in certain of the other families.

Kangaroos vary in size from species belonging to the typical genus *Macropus* (**1396–1406**) as large as a man, through the smaller kinds known as Wallabies (fig. 45), to others smaller than a Rabbit, such as the Kangaroo-Rats, or Rat-Kangaroos, *Potorous* (**1415, 1416**). Of those exhibited may be specially mentioned the Great Red Kangaroo, *Macropus rufus* (**1405**), the largest of the family, and the beautiful Yellow-footed Wallaby, *Petrogale xanthopus* (**1410**), the most brightly-coloured species of the

† "With two front teeth." ‡ "With many front teeth."

group, as well as a species of Tree-Kangaroo, *Dendrolagus* (**1411** and **1412**). Very curious, too, is the little Musk-Kangaroo, *Hypsiprymnodon moschatus* (**1422**).

In Kangaroos and Wallabies the dental formula, when fully developed, is I. $\frac{3}{1}$, C. $\frac{1}{0}$, P. + M. $\frac{8}{8}=34$; some of the front grinding-teeth, however, are generally lost before the hinder ones are in position.

Fig. 45.

Parry's Wallaby (*Macropus parryi*).

Numerous fossil remains of animals allied to Kangaroos, some as large as a Rhinoceros, have been found in the superficial deposits of Australia, among which may be specially mentioned the huge *Diprotodon australis* (**1425**), of which a cast of the lower jaw is exhibited in case 69. A fine series of remains is shown in the palæontological gallery.

The Australian Opossums and their relatives, collectively known as Phalangers (*Phalangeridæ*), differ from the Kangaroo group by [Case 70.]

the possession of a large opposable great toe, and the comparative shortness of their hind-feet. The teeth are variable in form and number, the genera of the family being founded almost entirely on these variations. The dental formula ranges from I. $\frac{3}{1}$, C. $\frac{1}{0}$, P.+M. $\frac{5}{4} = 28$, to I. $\frac{3}{1}$, C. $\frac{1}{1}$, P.+M. $\frac{7}{7} = 40$. In the curious *Tarsipes rostratus* (**1446**) the molar teeth are so reduced and variable that no definite number can be assigned to it. The hind-feet are of the same type as in the Kangaroos, but the disproportion between the bones of the united second and third toes on the one hand, and the fourth on the other, is not so great as in those animals.

The members of this group vary in size from that of a Mouse, as for example the Pigmy Flying Phalanger, the Flying Squirrel of the Colonists, *Acrobates pygmæus* (**1441**), to others larger than a Cat, such as the Native Bear, or Koala, *Phascolarctus cinereus* (**1414**). Skeletons are exhibited of the latter animal, of a Cuscus, *Phalanger maculatus*, and of a Flying Phalanger, *Petaurus sciureus* (**1437**).

Of the more noticeable types, the following may be mentioned:—

The Shrew-like *Tarsipes rostratus* (**1446**), a little long-nosed animal with an extensile tongue, and three distinct stripes down its back, which feeds on insects and honey, and is confined to Western Australia.

[Case 69.] The Australian Opossums, or true Phalangers, *Trichosurus* (**1442**), Cat-like animals, with thick fur and long bushy tails; the finely-marked Striped Phalanger, *Dactylopsila trivirgata* (**1435**), of New Guinea; the Dormouse-Phalangers, *Dromicia* (**1439**); the larger Moluccan Cuscuses, *Phalanger* (**1429, 1430**); and, finally, the Flying-Phalangers, or Australian Flying-Squirrels, *Petaurus* (**1436**), which, like true Flying-Squirrels, have a lateral extension of the skin of the body, forming a parachute.

The Native Bear, or Koala, *Phascolarctus cinereus* (**1414**), is a curious species, somewhat similar in its general appearance to a little Bear, but a vegetable-feeder, living chiefly on the leaves of gum-trees. It is of a harmless and peaceable disposition, of about the same size as a Wombat, with long ashy-grey hair, tufted ears, no tail, and five toes on each of its feet. It is related both to Phalangers and Wombats.

The Wombats, *Phascolomyidæ* (**1393—1395**, fig. 46), are rather clumsily-built animals, somewhat resembling Marmots in general form, with a short, rounded head, short ears, scarcely any tail, and long powerful claws with which they dig their burrows. There are three species, very similar externally, distributed over the whole of Australia and Tasmania, and living on roots and other vegetable food. They often exceed 100 lb. in weight, and are valued as food. [Case 69.]

Fig. 46.

The Common Wombat (*Phascolomys ursinus*).

Wombats are the only Marsupials with rootless teeth and an equal number of incisors in each jaw, their dentition being I. $\frac{1}{1}$, C. $\frac{0}{0}$, P. + M. $\frac{5}{5} = 24$. The incisors are large and cutting, with the enamel confined to the front surface, as in Rodents. The cheek-teeth are strongly curved, and composed of two parallel lobes each. The general form is stout and squat, and the tail rudimentary, consisting of only from 8 to 12 vertebræ, while the Phalangers have from 25 to 31. The hind-feet show a slight tendency towards the Kangaroo-structure.

The Bandicoots, *Peramelidæ*, are the first examples of the "polyprotodont" carnivorous dentition, that is one with many incisors in the lower jaw, and with the lower and upper canines [Case 70.]

well developed, and suited for seizing and holding small Mammals, birds, worms, beetles, &c. The dental formula is I. $\frac{5}{3}$, C. $\frac{1}{1}$, P. + M. $\frac{7}{7} = 48$. On the other hand, the hind-feet show a close resemblance to those of the Kangaroos, so that these animals are in some measure intermediate between the two great groups of Marsupials.

Some of the more important members of the family are the Striped Bandicoot, *Perameles fasciata* (**1464**), of Tasmania; the Long-nosed Bandicoot, *P. nasuta* (**1465**), of New Guinea; the long-eared Rabbit-Bandicoot, *Peragale lagotis* (**1468**), of Western Australia; and the little Pig-footed Bandicoot, *Chœropus castanotis* (**1467**), an animal somewhat resembling a Rat, but with fore-feet recalling those of a Pig.

[Case 70.] Allied to the Bandicoots are the carnivorous *Dasyuridæ*, in which the feet are of the ordinary type, with five toes on the fore and four on the hind pair.

Fig. 47.

The Pouched Wolf, or Thylacine (*Thylacinus cynocephalus*).

The *Dasyuridæ* are the most highly developed carnivorous Marsupials, representing in this order the Carnivora of the placental series. The largest is the Thylacine or Pouched Wolf, *Thylacinus cynocephalus* (**1484**, fig. 47), whose skull strikingly

resembles that of one of the Dog tribe. Its dentition is I. $\frac{4}{3}$, C. $\frac{1}{1}$, P. + M. $\frac{7}{7}$ = 46, the teeth being sharp and cutting, and well suited to its predatory habits. The feet are like those of a Wolf, and the marsupial bones are represented by cartilages. Externally the Thylacine is remarkably like a striped Wolf. For a long time it was the bane of the Tasmanian settlers, owing to the havoc it created among their sheep; but it has now been nearly exterminated, and at no distant period will be quite extinct. No Thylacines now live on the continent of Australia, but their fossil remains have been found in bone-caves in New South Wales.

The second largest member of the family is the well-known Tasmanian Devil, *Sarcophilus ursinus* (**1482**), which has earned its English name by its untamable disposition and the damage it does to poultry and game.

The Native Cats, or Dasyures (**1477—1481**), are small animals of about the size and proportions of a Cat. They are wholly carnivorous, living on eggs, small birds, mammals, and insects, and thus corresponding in their habits to the Weasels, Martens, and other small placental Carnivora; while the still smaller species of *Phascologale* (**1470—1474**) and *Sminthopsis* (**1476**), which range from the size of a Rat to that of a Mouse, and live on insects, worms, &c., represent the placental Insectivora. Their teeth are numerous, small, and covered with sharp pointed cusps.

The Banded, or Marsupial, Anteater, *Myrmecobius fasciatus* (**1469**), is one of the few Mammals marked with cross-bars. About the size and shape of a Squirrel, it has a long pointed snout and extensile tongue, with which it catches ants and other small insects. It is a native of Western Australia, and remarkable for the large number of its teeth, the dentition being I. $\frac{4}{3}$, C. $\frac{1}{1}$, P. + M. $\frac{9}{9}$ = 54. The teeth are small and sharply cusped.

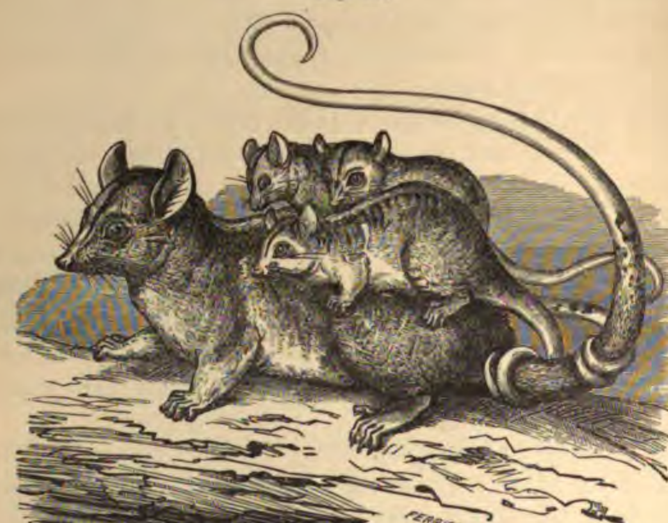
The American Opossums, or *Didelphyidæ*, resemble in their dentition the *Dasyuridæ*, and in the structure of their feet the Phalangers, the first hind-toe being opposable to the other toes, and so forming a posterior pair of hands. The dental formula is I. $\frac{5}{4}$, C. $\frac{1}{1}$, P. + M. $\frac{7}{7}$ = 50.

The species of American Opossums are numerous; but in no family of equal extent are there so few differences in the

characters of the skeleton—the skulls, teeth, and proportions of the limbs being in all nearly identical.

These Opossums are almost the only living extra-Australian members of the order, being limited to America, where they range from the United States to Patagonia, the number of species being greatest in the more tropical parts. They are characterized externally by their slender build, long noses, well-developed prehensile tails, and above all by their hind-feet being provided with a great toe, which, as already stated, is opposed to the other

Fig. 48.



An American Opossum (*Didelphys dorsigera*).

toes, and enables the animal to grasp boughs or other objects; it is without nail or claw, and has only a broad, flat, fleshy pad at its tip. Of the *Didelphyidæ* the most worthy of mention is the Common Opossum, *Didelphys marsupialis* (**1458**), a native of all the countries from the United States to Brazil, and everywhere found in great abundance. It is of the size of a Cat, and feeds on all sorts of animal and vegetable substances, living even in towns, where it acts as a natural scavenger. Other South-American species are smaller, some little larger than a Mouse. The females

carry their young on the back (fig. 48, No. **1450**), the latter using their prehensile tails by twisting them round that of their mother.

The Yapock or Water-Opossum, *Chironectes minimus* (**1447**), differs from other Opossums in having its toes webbed like those of an Otter; it is wholly aquatic in its habits, and lives on water-beetles and crustaceans. Its colour is of a general ashy-grey, with five or six broad slaty-brown bands across the back, standing out in high relief against the ground-colour of the body.

Fossil remains of Opossums are of special interest, on account of being found in the Eocene deposits of England and France. These fossils consist, however, chiefly of lower jaws, so that it is by no means easy to tell their exact relations to their modern representatives.

The family *Notoryctidæ* consists of a single and remarkable animal inhabiting the sandy deserts of the centre of Australia, the Marsupial Mole, *Notoryctes typhlops* (**1443**). This little animal bears very much the same relation in its structure and habits to the other Marsupials that the Moles and Golden Moles (pp. 30 & 31) do to the other Insectivora, and the Mole-Rats (p. 58) present to other Rodents. It lives chiefly underground, burrowing in the sandy soil, and feeding on worms, grubs, &c. Its snout is provided with a peculiar naked pad or shield with which it forces its way through the earth; the tail is short and entirely naked; the eyes are practically aborted, as also are the ears; and the fore-feet, with which it burrows, are modified somewhat in the same way as are those of the Golden Moles (*Chrysochloris*). The third and fourth toes bear large digging claws, while those of the other three are small and slender.

The skeleton of this little animal, exhibited in case 70, is remarkable for its generally Mole-like structure, powerful fore-limb, with its stout and highly ridged humerus, the united neck-vertebræ, the first and the seventh being alone free, and for the peculiar roofing-in of the sacrum by the expansion of the processes of the sacral vertebræ. The teeth vary slightly in number, but the ordinary formula appears to be:—I. $\frac{3}{2}$, C. $\frac{1}{1}$, P. + M. $\frac{6}{7}$ = 40.

A second South American group is now represented by the living genus *Cænolestes*, referred to the family *Epanorthidæ*, of which

numerous fossil remains have been discovered in the Tertiary formations of Patagonia. On account of its rarity, no example of this animal is at present shown.

Order XI. MONOTREMATA, or Egg-laying Mammals.

(Lower Gallery, Case 71.)

The order Monotremata, like the Marsupialia, represents by itself one of the primary sections or subclasses into which Mammals are divided. In all their anatomical characters its members show a remarkably low type of organization, doubtless transmitted more or less directly from some of the earliest Mammalian forms.

Monotremes present many important skeletal characters, among which may be specially noticed the peculiar structure of the shoulder-girdle, in which the clavicle is large, and connected with the sternum by an "inter-clavicle"; the coracoid, instead

Fig. 49.

The Echidna, or Spiny Anteater (*Echnida aculeata*).

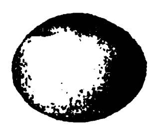
of being rudimentary as in other Mammals, is large, and articulates with the sternum; and the whole structure is of a very low and Reptile-like type. The skull is long and depressed, with a large rounded brain-case, the walls of which are thin, as in Birds. There are no true teeth in adult life, but in the Platypus the young are provided with three pairs of peculiar

flattened saucer-like teeth in each jaw, which are afterwards shed and replaced by horny plates. There are 19 vertebræ in the trunk, well-marked sternal ribs, and a pair of large marsupial bones placed on the pelvis.

The two families of the order differ in many important respects, especially in the shape of the skull. The Duck-billed Platypus, or Platypus, *Ornithorhynchus*, has a broad, flat expansion, forked in front, which supports the beak, and in which first the teeth and then the horny plates are implanted; while in the Spiny Anteaters, *Echidna* (fig. 49), the snout is long, narrow, and toothless, and forms merely a long tube for the lodgment of the tongue, as in the true Anteaters. In *Pröechidna bruijnii* from New Guinea, of which a skeleton is mounted, the snout is nearly twice as long as the brain-case, and very much curved downwards, but in the common *Echidna* it is shorter and curved upwards.

In both families the fore-limbs are more powerfully developed

Fig. 50.



The Egg of a Spiny Anteater, or Echidna; nat. size.

than the hind pair, the humerus especially being exceedingly thick, and provided with large ridges for the attachment of muscles.

Monotremes lay eggs and the Echidnas have a breeding-pouch, but the mode of incubation is not yet satisfactorily known. They are without true nipples, the milk exuding from groups of pores in the skin. The males are provided with horny spurs on the heels, connected with a small gland on the back of the thigh. The temperature of the blood is lower than that of other Mammals, observations having shown that in *Echidna* it stands only at about 78°, some 20° lower than that of Man, and about 30° below that of the average of Birds.

The Spiny Anteaters, *Echidnidæ*, are characterized by the long narrow snout, small mouth, long worm-like tongue, want of teeth of any sort, rudimentary tail, free toes with stout digging claws, and spiny porcupine-like coats. This family contains *Echidna*

aculeata (**1485**, fig. 49), with five toes to each foot, from Australia as well as New Guinea, and the Three-toed Echidna, *Pröechidna bruijnii* (**1486**), confined to the mountainous region of Northern New Guinea.

Spiny Anteaters live exclusively on ants, which they catch with their long extensile tongues, like the true Anteaters. Their palates are covered with rows of horny spines, which serve to scrape the ants off the tongue when it is withdrawn into the mouth.

Fig. 51.

The Duck-billed Platypus (*Ornithorhynchus anatinus*).

By the help of their strong curved claws they are able to bury themselves in loose soil in a very few minutes. The two eggs are carried about by the female in the temporary pouch till they are hatched. A specimen (fig. 50) is exhibited in the case.

The Platypus (fig. 51), representing the family *Ornithorhynchidæ*, is, as already stated, distinguished by the structure of the muzzle, which resembles the beak of a Duck, and is provided with the above-mentioned horny plates, which in the adult serve the purpose fulfilled during youth by temporary true teeth (fig. 52); the tail is long and broad, and the toes are webbed. The coat consists of thick, close hair without any spines. The eggs, two in number, are believed to be deposited in the burrow.

The only species is the Duck-billed Platypus, or Water-Mole, *Ornithorhynchus anatinus* (**1487**, fig. 51), which, as might be expected

from its structure, is entirely aquatic, feeding on other water-animals, for which it searches in the mud in the same manner

Fig. 52.

The Temporary Upper Teeth of the Duck-billed Platypus.

as a duck. Like the Spiny Anteater, it is a native both of Australia and Tasmania, but has not been found in New Guinea.

INDEX.

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2.

A GUIDE

TO THE

DOMESTICATED ANIMALS

(OTHER THAN HORSES)

EXHIBITED IN THE CENTRAL AND NORTH HALLS

OF THE

BRITISH MUSEUM (NATURAL HISTORY)

CROMWELL ROAD, LONDON, W.

ILLUSTRATED BY 24 FIGURES.

LONDON:
PRINTED BY ORDER OF THE TRUSTEES OF
THE BRITISH MUSEUM.
1908.

Fig. 1.

Ancient Egyptian Ox.

PREFACE.

ALTHOUGH there are a few specimens which have been in the Museum for many years, the collection of Domesticated Animals is mainly of quite recent origin. The importance of the study of Domesticated Animals to the scientific naturalist is indicated in the following extract from the works of Professor Ernst Haeckel :—

> "Wild animals and plants, one year after another, appear approximately in the same form, and thus give rise to the mistaken doctrine of the constancy of species; domesticated animals and plants, on the other hand, display great changes within a few years. The perfection attained by breeders and gardeners in the art of selection enables them to produce entirely new forms in a short time. For this purpose it is only necessary to keep and propagate the animal or plant under special conditions, when, after a few generations, new species may be obtained, differing from the original form in a much higher degree than do many wild species, or even genera, from one another. The importance of this fact cannot be over-estimated in connection with the origin of species."

The interest of the collection to breeders, fanciers, and the public generally is self-apparent.

The present Guide-book, which has been written by Mr. Lydekker, includes the whole of the collection of Domesticated Animals, other than Horses and Asses; these latter forming the subject of a separate work.

R. BOWDLER SHARPE,
Assistant Keeper, Department of Vertebrate Zoology.

BRITISH MUSEUM (NATURAL HISTORY),
CROMWELL ROAD, LONDON, S.W.
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A GUIDE

TO

DOMESTICATED ANIMALS

(OTHER THAN HORSES).

Domesticated Cattle. The Domesticated Cattle of Europe are in most cases descended from the extinct black Wild Ox or Aurochs (*Bos taurus primigenius*), which survived in Poland till the middle of the 16th century. The earliest domesticated breed in Great Britain is the Celtic Shorthorn (commonly called *B. longifrons*), of which the remains occur in Prehistoric and Roman deposits. The White Cattle of Chillingham, Chartley, and certain other British parks have been regarded as truly wild animals; but their colour is alone sufficient to indicate that they are the semi-albino descendants of domesticated breeds. In addition to these, the more important native breeds met with in the British Islands are the Shetland, Highland, Pembroke or Welsh, Kerry, Polled Angus, Ayrshire, Galloway, Polled Suffolk, Devon, Hereford, Long-horn, and Short-horn. The Jersey, Guernsey, and Alderney breeds have been introduced from the Channel Islands. Among Continental breeds, the long-horned and fawn-coloured Hungarian Cattle, which range through Turkey into Western Asia, and the whitish, long-horned Podolian Cattle of Poland and North Italy, characterised by the height of their fore-quarters, show evident signs of affinity with the Aurochs in the black "points" of the adult bulls. The cows and calves, on the other hand, are wholly white.

European Cattle have been introduced into America, Australia, New Zealand, etc., where they have become half-wild. In South America the Niatu, or Snub-nosed Cattle, form a very remarkable breed.

Chillingham Park Cattle. The White Cattle of Chillingham Park, Northumberland (like those of certain other British parks), are, as already mentioned, semi-albinos, descended (as indicated by their red or black ears) from dark-coloured Cattle, allied to the Welsh, or Pembroke, breed, which is one of the oldest in Britain, and nearly related to the Aurochs. There is a white strain of Pembroke Cattle, with the ears, muzzle, and fetlocks black, to which the Chillingham Cattle come very close. In shape the black-tipped horns of the Pembroke and Chillingham breeds are identical. Pembroke Cattle show, however, a tendency to develop into the long-horned type, and there is little doubt that the under-mentioned White Cattle formerly kept at Chartley Park, Staffordshire, are a breed showing this tendency. In the Chillingham Cattle the ears were formerly red, but are now black. Red ears could easily be developed from black ones by a kind of degenerate modification. The Aurochs appears to have been generally black, at least in the case of the bulls, but there may have been a red race, or possibly the cows may have been of that colour.

The Chillingham breed is represented in the collection by a bull, the gift of the Earl of Tankerville (1890); the heads of a bull and a cow, also presented by Lord Tankerville in 1885; and the skeleton of a bull, presented by the Duke of Hamilton in 1890.

Pembroke Cattle. The white breed of Pembroke Cattle is referred to on page 241 of Low's 'Domesticated Animals of the British Islands' as having been formerly common in that county, and a herd is still kept by Mr. C. Matthias, of Lamphey Court and Rhysgwyllt, Pembrokeshire. As mentioned by Low, these cattle are wholly white, with the exception of the inside and part of the outside of the ears, the muzzle, and the feet as far up as the fetlock-joints, which are black. In these respects, as well as in the form of their black-tipped horns, they are essentially the same as the Chillingham Park breed, although the coat is shorter and more sleek. They prove beyond doubt that the Chillinghams are albino Pembrokes, while the latter are as undoubtedly the direct descendants of the Aurochs.

It is noteworthy that on page 307 of Low's book reference is made to the fact that, when transferred from its native mountains to the lowlands, the Pembroke breed displays a tendency towards the Long-horn type, and it seems, indeed, to have been Low's opinion that the Long-horn breed is a derivative of the Pembroke. This opinion is exceedingly important, for it serves to bring the

Chartley Cattle, which are evidently of the Long-horn type, into line with the Pembroke, and thus with the Chillingham breed. They are, in fact, albinos of that section of Pembrokes which has given rise to the Long-horns, just as the Chillinghams are derived from albinos of the typical mountainous Pembroke breed. The tendency to black brindling in strawberry-roan Long-horns is doubtless a throw-back to the ancestral colour, the normal roan or red being easily derived from the black Pembroke, as is exemplified by several local strains of that breed, and likewise by the red ears, which, as the result of selection, formerly characterised the Chillingham breed.

The normal black Pembroke breed is at present represented in the collection by the mounted head of an ox.

Chartley Park Cattle. Most of the small remnant of the herd of White Cattle which had been maintained since the year 1248 at Chartley Park, Staffordshire, was acquired a few years ago by the Duke of Bedford and transported to Woburn Park. Soon after the arrival of the herd at its new home in 1906 two of the cows died from tubercle, when their skulls were presented by the Duke to the Museum, where they are now exhibited on the top of one of the Cattle cases. As may be seen by comparison with those of other breeds exhibited on and in the same case, the Chartley skulls differ widely from the type characteristic of the Chillingham and Pembroke breeds in the setting-on and shape of the horns, and come much nearer in this respect to the Hereford, Devon, and Long-horn breeds, all of which are probably more or less nearly related. The horns, for instance, are not set upon the very topmost ridge of the skull, but somewhat below this; and instead of being directed upwards in the pitchfork style characteristic of the Chillinghams and Pembrokes, bend downwards and inwards in the Long-horn and Hereford fashion. Moreover, although the horns are somewhat darker at their terminations than elsewhere, they do not show the well-defined black tips characteristic of the Chillingham and Pembroke type. So far as their skulls and horns are concerned, the Chartley Cattle appear to be more nearly related to the Long-horn and Hereford breeds than to the Chillingham, Pembroke, and Short-horn strains. On the other hand, the Chartley, like the Chillingham Cattle, exhibit a marked tendency to throw back to a black type; and a cow and her calf among the survivors of the herd sent to Woburn were wholly black. Now black is not to be met with (at all events normally) either among the Devons, Herefords, or Long-horns; red being characteristic of the two former, while

strawberry-roan, or bay, is prevalent in the latter. The probable origin of the Chartley Cattle from a special branch of the Pembroke is alluded to in the paragraph devoted to that breed. In addition to the two skulls mentioned above, the breed is represented in the collection by the mounted head of a cow, also presented by the Duke of Bedford in 1906.

Highland Cattle. The Highland breed, which is nearly related to the Pembroke, although generally bay or fawn in colour instead of black, is represented in the collection by the head of the bull 'Sconach Ruadh,' presented by Mr. J. H. Leigh in 1903.

Kerry Cattle. The Cattle of Kerry, together with other Irish mountain-breeds, are related to the Pembroke and Highland Cattle and to the white Park breeds, with which they agree in the form and colour of their horns, and their soft, unctuous, orange skins. They are generally black, with a whitish line along the spine, this light dorsal streak being a feature common to the Spanish Fighting Bull and the extinct Aurochs. The Dexter-Kerry, which may be red, is an improved breed, taking its name from an agent to a former Lord Hawarden; the light dorsal streak is lost.

The latter breed is represented in the collection by the mounted skin of a black ox, purchased in 1900, and also by the head of a red cow (a prize-winner), presented by Mrs. Leatham in 1903.

Short-horns. The Short-horn breed is represented by the replica of a miniature model of a Holderness ox, made by G. Garrard, A.R.A., in 1800, showing the form of this breed more than a century ago. The original is in the possession of the Duke of Bedford. There are also three mounted heads of bulls. The first of these is 'Duke of Tregunter' (Herd-book, No. 26,021), presented by the Short-horn Society in 1906. This celebrated bull, which was bred by Sir R. Gunter in 1867, was the son of 'Duke of Wharfdale 3rd,' and a typical example of the 'Bates' strain. When five months old, it was sold for £525. The second head is that of 'Knight of the Shire' (Herd-book, No. 26,552), a son of 'Commander-in-Chief,' and bred by Mr. T. C. Booth in 1867. This bull, which sold for £1,323 as a calf, was a fine example of the 'Booth' strain. This specimen was likewise presented by the Short-horn Society in 1906. The third head is that of 'Scottish Archer,' a bull owned by Lord Middleton, the donor of the specimen.

The prevalence of bay and strawberry-roan, mingled with white, in Short-horns (which are evidently derivates from the Aurochs-Pembroke type) indicates how the same colour may have been evolved in the case of Herefords and Long-horns from the black Pembroke.

Long-horns. The Long-horn breed, which, as mentioned above, appears to be related to the Chartley, and thus to the Pembroke breed, is represented in the collection by a replica of a miniature model of a Leicester Long-horn Ox, made by G. Garrard, A.R.A., in 1800, which shows the form of this breed more than a century ago. The original is in the possession of the Duke of Bedford. Also by the mounted head of a bull bred in the Isle of Man, and presented in 1907 by Mr. G. C. Bacon, and another of a cow, from Norfolk, presented by Mr. E. Tingey in 1903.

Devons and Herefords. Of these breeds the collection includes a replica of a miniature model of a Devon cow, made by G. Garrard, A.R.A., in 1800, which is of interest as showing the form of this breed more than a century ago. The original is in the possession of the Duke of Bedford.

There is also the mounted head of an Ox of the same breed, and likewise one of a Hereford Ox; the one purchased in 1900 and the other in 1901.

Polled Cattle. The Polled, or Hornless, breeds are represented in the collection by the mounted head of a Red Polled Ox from Norfolk, presented by Mr. F. Crisp.

Jersey Cattle. Of the Jersey breed the Museum possesses the head of the bull 'Viceroy' (Herd-book, No. 6102), presented in 1901 by Mr. Edwin Brough, the owner and breeder. As mentioned later, Jersey Cattle present a certain approximation to the Spanish fighting breed.

Some Continental Breeds. One well-known breed is represented by a miniature model of a Friburg or Simmenthal Bull from Simmenthal, in Switzerland, which was purchased in 1901. This breed, which has many of the characters of the Short-horn, but with the body and neck longer, is an ancient one probably derived directly from the Aurochs. The colour may be either black and white or fawn and white.

A nearly allied breed is represented in the collection by a miniature model of an Allgau bull, from Hungary, which was purchased in 1901.

Although there are at present no examples in the Museum, reference may be made to the black and white or brown and white Dutch Cattle, which seem to approximate to the Ayrshire breed, and have spread from Holland over a large part of Germany. They are regarded as direct descendants of the Aurochs.

In the Volhynian province of Poland occurs a breed resembling in general characters the ordinary black and white or chestnut and white cattle of Western Continental Europe. In a very considerable percentage of these cattle (whether the dark areas are black or chestnut) a broad and uninterrupted white stripe runs along the whole length of the spinal region; the rest of the body being pied in the ordinary manner. This white dorsal line gives to those individuals in which it occurs a unique and unmistakable appearance, this peculiar type of colouring being apparently less common in the Dutch breed, in which, however, it may sometimes be seen. As already mentioned, the Aurochs (which survived to a later date in Poland than elsewhere) is known to have had a light dorsal stripe in its otherwise black coat, a trace of this being noticeable in some of the black Spanish fighting bulls. If the domesticated cattle of Poland be the descendants of the wild race, it seems probable that, with the development of partial albinism, the light dorsal line of the ancestral form would be the first area to turn white; and that this white stripe would have a strong tendency to persist in the breed, even when a further advance towards albinism is displayed by the replacement of the black areas by chestnut. In the form, colouring, and direction of their horns the Polish Cattle are essentially Aurochs-like, and in the prevalence of the white dorsal band appear to present further evidence of near kinship with the ancestral Wild Ox.

Very different to any of the above are the large pale-coloured and long-horned Podolian and Hungarian Cattle. The latter are represented by a miniature model of the Hungarian bull, 'Hunyadi,' bred at Meszhegyes, as well as by the model of a second bull of the same type.

These models (which were acquired by purchase) show that in the bulls of this breed the general drab colouring is relieved by black markings round the eyes, and on the muzzle, dewlap, and other parts of the head and body. In the oxen, on the other hand, as represented by a fine head exhibited in the wall-case and purchased

about 1840, and likewise in the cow, the whole head and body is uniformly whitish or drab. The retention of the dark 'points' in the adult bulls affords, in all probability, decisive evidence of the descent of the breed from the Aurochs.

Spanish Cattle. Spanish Cattle, of which three types are recognised, namely, the Northern Gallego (Aragon) and Navarra breeds, the Central or Castilian breed, and the Southern or Andalucian type, are represented in the collection by a black Fighting Bull, the gift of Mr. Farquharson Johnston, as well as by two mounted heads and a skull and horns of the fawn-coloured Draught Oxen, which were presented by H.M. the King, and pertained to living specimens presented by the Empress Eugénie to H.M. Queen Victoria, by whom they were kept for some years at Osborne, Isle of Wight. Miniature models of these royal cattle are likewise exhibited.

Of the three types, the Gallego and Navarra, or northern form, is characterised by its regular proportions, generally light colour (yellowish-fawn or pale chestnut), and large horns, which are directed mainly upwards and backwards. The central, or Castilian breed, on the other hand, is distinguished by great size and stoutness, the straight line of the back, the dusky colour, which is often almost black, and the well-proportioned horns, which are directed mainly forwards. Finally, in the southern or Andalucian type we find the size and build medium, the line of the back sinuous, the colour generally dusky, although sometimes black and white, or even chestnut and white, and the horns of the same type as in the preceding. The horns of the last two breeds may, indeed, be compared to those of the tines of a pitchfork held horizontally, with the concavity upwards; while those of the first or northern type may be likened to the same instrument held vertically, with the concavity of the tines backwards. These three main breeds or types may be divided into eight sub-races or strains, probably induced by crossing and local conditions, the characteristics of which cannot be given in this place.

Ancient bronze bas-reliefs of the Celto-Iberian epoch, as well as certain ancient Spanish coins, exhibit unmistakable representations of the northern type, with its large upwardly-directed horns, and it would accordingly seem that this was the breed possessed by the ancient inhabitants of the Peninsula. This is confirmed by the existence of a similar type of Cattle over a large part of southern Europe, especially Italy and Greece, as indicated on the ancient

monuments of these countries. This large-horned breed of light-coloured Cattle, it has been suggested, is derived from the Zebu or Humped Cattle by the elimination of the hump as the result of selection. Be this as it may, the breed seems to be of Eastern origin, and to have been imported into Spain in a domesticated condition.

Such a breed introduced by the Greeks and Romans cannot but have modified and absorbed the indigenous Spanish Cattle, and it is to this Græco-Roman importation that the uniform colour of the Cattle of northern Spain is due. It is known that fawn or chestnut was specially favoured by the ancient Romans in their Cattle, and it is this colour which is most prevalent among the Cattle of Gallego and Navarra. Nevertheless, there are a certain number of white Cattle which may be the descendants of the Roman sacrificial breed.

The existence of the large-horned and light-coloured breed of Cattle in the Peninsula during Celto-Iberian times being proved, it remains to demonstrate the presence, at the second epoch, of Cattle resembling the modern Castilian and Andalucian breeds. The most important piece of evidence is the 'stone of Clunia,' which was in existence in Peñalva in 1774, but subsequently destroyed. On this Celto-Iberian monument was represented a bull-fighter, in full array, prepared to receive the charge of a bull, while the legend is the ancient equivalent for a bull-fight.

In this monument (unlike those of the same period already referred to) the bull is represented with horizontally-directed horns of the type of those of the Castilian and Andalucian breeds and also of the Aurochs. Whether the animal depicted was a wild bull (the Aurochs doubtless existing at this date in Spain as in the rest of Europe) or a domesticated individual cannot be definitely determined; but it indicates the existence in the Celto-Iberian epoch of Cattle with the Aurochs-type of horns. In accord with this is the close resemblance of the modern Spanish Cattle of the Castilian breeds to the Aurochs, as described and figured by Herberstain in the sixteenth century. Not only have the horns the same general form and direction, but the black hue of the modern breeds is the same as that of their extinct relative; while more important still is the fact that both the Aurochs and the Castilian bulls show a fawn-coloured line running down the middle of the back.

It has accordingly been suggested that the Cattle of central Spain are the direct descendants of the wild Aurochs. The southern or Andalucian breeds seem, on the other hand, to have been crossed with Cattle imported by the Arabs, which would account for their

inferior size and frequently piebald colouring. The difference in size between the large Gallego and the small Navarra Cattle of the northern type may be largely due to the mountain habitat of the latter. The Castilian and Andalucian bulls and those of the Navarra breed of the northern type are employed in the ring, while the large Gallego Cattle are those used for draught and agriculture.

The affiliation of the black Castilian, and in a less degree the Andalucian, breeds of Spanish Cattle to the wild Aurochs strengthens the opinion as to the existence of an intimate relationship between ancient Welsh and Irish breeds, like the Pembroke and Kerry, to the latter.

Of not less interest is a theory that the large-horned and dun-coloured northern Spanish breed of Cattle, together with the large, light-coloured Cattle of Greece, Italy, and certain other parts of southern Europe, are descended from the humped Zebu. This approximation to the Zebu type is shown by the horns of the two heads of Spanish Draught Cattle presented by the King to the Museum, which are exhibited in the case on the south-west side of the North Hall.

The horns of all Humped Cattle—both Indian and African—differ from those of the Aurochs and the related types of European domesticated cattle by their distinctly lyrate shape, the first main curve having the convexity in front instead of behind. Their tendency is also to grow upwards and backwards, rather than forwards, and they may be, as in the Galla Cattle, very large. Other characteristics of the Zebu are to be found in the large dewlap, and the white rings round the eyes and the fetlocks; the light fetlock-rings being remarkably constant in all the half-breeds so common in Northern India. Now, Spanish Draught Cattle of the Gallego breed not only exhibit an approximation to the Zebu, and especially to the Galla, type in the direction, curvature and size of the horns, but also show a similar large dewlap, and light rings round the eyes and the fetlocks. The horns of the large whitish Italian Cattle also approximate, especially in direction, to the same type; and to a certain extent a similar feature is noticeable in the horns of the large pale-coloured Podolian and Hungarian Cattle, breeds which also have a large dewlap, and, despite their light colour, traces of white rings round the eyes and the fetlocks.

The foregoing features observable in the north Spanish and other light-coloured South European Cattle are those we should expect to find retained in breeds descended from the Zebu, which have been so altered by selection and crossing (probably with the

and zebu-less Cattle of Europe) as to have lost the characteristic hump of the ancestral stock.

This Zebu ancestry can, however, only be regarded as a suggestion, which accords with the available facts, and if confirmed would clear up many difficulties.

Whether the Zebu theory be true or not, there appears to be justification for assuming a dual ancestry for the Cattle of Europe. On the one hand we have the Aurochs-like breeds, such as the Castilian, Andalucian, Channel Island, Pembroke, Kerry, Highland, and white Park Cattle, which are evidently the direct descendants of the wild Aurochs, and are usually uniformly black or chestnut in colour, except when they display albinism. On the other side are the large-horned north Spanish, Italian, Grecian, and Hungarian breeds, which are all light-coloured animals, with large dewlaps and white rings round the eyes and fetlocks, and are almost certainly the descendants of a second ancestral stock.

The following are some of the chief herds kept for the ring :—

Of the northern, or Navarra, breed, the best are Perez Laborda's and Lizazo's, both at Tudela, near the Aragon border ; others, of a mountain type, are kept near Tolosa, on the Guiyuzcoa side of the range.

Of the central, or Castilian, breed, the herd of Maspule, of Valladolid, to which belonged the famous 'Senorito,' was incorporated with that of the Marques de Gartiria, of Gijon. The Duque de Veragua's herd, dating from 1780, and known as 'La Munoza,' of Aranjuez, was incorporated with that of Ulloa, from Utrera, Andalucia, and is thus mixed. North of Madrid are the herds of Gomez, Aleas, Vicente Martinez, and Fuentes ; the two last known as 'de la Moral zarzal,' and renowned for strength and bravery. Another Castilian herd is that of Don Estaban Hernandez. There are also herds in La Mancha, such as those of Flores ; Barbera, near Ciudad Real ; Escalera at Menasalva, near Toledo ; as well as in Estremadura and at Villarubia. Others, again, are kept near Cordova, for instance the herds of Gutierrez at Almodovar and of Rivero.

Of the southern, or Andalucian, breed the following herds exist or recently existed near Seville, viz. : Miura, Camara, Muruve, Perez de la Concha, Anastasio Martin, Ybarress, Marques del Saltillo, Lesaca, Hernandez (Freire), Barquero, Benjumea, Concha Sierra, and Adalid. Others are Barrero, at Jerez de la Frontera ; Larraz, at San Lucar de Barrameda ; and Herrara, at Puerto de Santa Maria.

FIG. 2.

HEAD OF ANKOLI COW.

FIG. 3.

BANTING STEER FROM BALI.

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Niatu Cattle. The Niatu Cattle of South America are characterised by the remarkable shortening of the bones of the nose and muzzle, the latter of which is much turned up, the palate being in consequence highly convex. The lower jaw projects in front of the muzzle. In colour these Cattle are generally black and white. They are represented in the collection by a skull of a Niatu Ox, from Buenos Aires, presented by Mr. G. Claraz in 1887.

Ankoli Cattle. In the big case on the south-west side of the North Hall is exhibited a mounted head of a cow of the long-horned Ankoli, or Uganda, Cattle; a skull and horns of a bull of the same species being shown on one of the pillars. The Ankoli Cattle (fig. 2) have no hump, and while the bulls are generally white, the cows are red. Their enormous horns are characterised by extreme slenderness, smoothness, upright direction, and wide separation—features in which they differ widely from those of the Galla Cattle. They are, moreover, placed at a much greater distance above the eyes than is the case in the Indian Zebu. In general form the skulls and horns of the Ankoli Cattle approximate to those of the much smaller ancient Egyptian breed, examples of which are exhibited in the same case. That these Cattle were also humpless is shown in an illustration of a fresco of the fifth dynasty, about B.C. 300 (fig. 1), framed on the pillar carrying the Ankoli bull skull. It thus seems probable that the modern Ankoli and the ancient Egyptian breeds are closely allied. The latter were identified by Dr. E. Lortet, in the *Archives* of the Lyons Museum for 1903, with the *Bos africanus* of Fitzinger and Brehm, that is to say, with the Galla Cattle, with which they have nothing to do. In 1904 the name *Bos ægyptiacus* was proposed by the author of the present Guide-Book for the ancient Egyptian Cattle, as typified by Dr. Lortet in the volume cited; the question being left open whether these cattle (to which the Ankoli breed may be provisionally affiliated) should be regarded as a distinct species, or merely as a local race of the European Ox (*Bos taurus*).

Humped Cattle. A perfectly distinct species is represented by the Humped Cattle, or Zebu (*Bos indicus*), of India and Africa, some of the characteristics of which have been already mentioned under the heading of Spanish Cattle. These Cattle take their name from the presence of a large fleshy hump on the withers; but they are also distinguished from ordinary Cattle by the form of their horns (in which the first curve is forward instead of backward), and the general presence of a whitish ring above each eye and round each fetlock. In India the colour, which may vary from very pale

fawn to drab, is generally uniform; but in Africa there are particoloured breeds. Some of the Indian breeds are dwarf.

The ordinary Indian breed is represented by a bull received from the Zoological Society in 1888.

In several of the African breeds of Humped Cattle, such as the Galla Oxen, the horns attain huge dimensions, especially in the matter of girth. Several fine pairs of horns are exhibited, among which is one presented by the Abyssinian traveller Salt.

FIG. 4.—NUER HUMPED OX. (From a photograph by Captain S. S. Flower.)

Near akin to the Galla breed are the Nuer Cattle, of the Eastern Sudan (fig. 4), which, in addition to a well-marked hump, have very massive, incurving, lyrate horns, with closely approximated tips (fig. 4). Humped Cattle with horns of a somewhat different type (fig. 5) occur on the Blue Nile.

The Nuer Cattle may be either uniformly or parti-coloured, but in West Africa the Moshi and Hausa Cattle are generally, if not invariably, parti-coloured, and often distinctly spotted. In one Moshi Ox the head, middle line of the back, and under-parts were white, and the greater portion of the neck and sides dark. In

Fig. 5.

BLUE NILE HUMPED OX.
(From a photograph by Captain S. S. Flower.)

Fig. 6.

HEAD OF UNICORN RAM.

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general characters these Cattle agree very closely with the figure of a Damaraland Ox given by Dr. Heck in the *Illustrirte Zeitung* for 1895, although in the latter the dark and light areas form an irregular marbling all over the head and body. Here may be mentioned plaster-casts of two enormous ox-horns received at the Museum from Madrid. Although their place of origin is unknown, they apparently belong to a breed allied to or identical with Galla Cattle. The largest specimen measures 47½ in. in length along the curve, and has a basal girth of 33¼ in.; while the corresponding dimensions of the smaller one (which contracts very suddenly in calibre near the middle) are 28¼ in. and 27½ in. In a Galla Ox skull presented to the Museum by Messrs. Denham and Clapperton the length of the horns is 42⅛ in. and the circumference 23⅝ in.

Gayal. Among the hill-tribes of north-eastern India and Tenasserim the heavily-built, olive-black Gayal or Mithan (*Bos frontalis*) is kept as domesticated cattle, the Kukis and Manipuris breeding large numbers of these animals. The Gayal is probably a domesticated breed of the wild Gaur, or Seladang (*Bos gaurus*), of India and the Malay countries, although it has received a separate scientific name (*Bos frontalis*). The head of a cow is exhibited in one of the large cases in the North Hall, and the mounted skin of a bull in the saloon at the end of the Lower Mammal Gallery.

Banting. In the Island of Bali, lying to the south-east of Java, the domesticated cattle are a tame breed of the wild Banting, or Bantin (*Bos sondaicus*), of Java, known to the Malays as Sapi-Utan (Wild Ox). Large numbers of domesticated Banting (fig. 3) are exported from Bali to Singapore for food. It is to Mr. C. Boden Kloss that the Museum owes a steer of this breed, which is exhibited alongside the big Zebu bull. The colour of the skin is rich maroon-brown, and the legs are wholly white from some distance above the knees and hocks to the hoofs. The white rump-patch is, however, much smaller than in the typical wild Banting, being confined to the hind side of the buttocks, and not surrounding the root of the tail.

Domesticated Buffalo. A domesticated, or semi-domesticated, breed of the Wild Asiatic Buffalo (*Bos bubalis*) is kept by the natives throughout India, Ceylon, and the Malay countries. Among the Hindu tribes, by whom all members of the Ox family are regarded as sacred, Buffaloes are kept only for the sake of their milk, or for agricultural and draught purposes. From India the domesticated breed was probably introduced at an early

date into Egypt and Western Asia, whence it has gradually spread into various parts of Southern Europe, such as Hungary, Italy, and Spain. Of late years Domesticated Buffaloes have been introduced into Australia. There is, however, a Pleistocene European race of the species from which it is possible that some of the domesticated stocks may have been derived. In the North Hall are shown miniature models of a male and a female of the domesticated breed, modelled from specimens bred in Hungary, and purchased in 1902.

Domesticated Sheep. The origin of Domesticated Sheep, of which the ordinary European breeds constitute the species *Ovis aries*, is not definitely known. Most European breeds differ from wild species in being clothed with wool instead of hair; the tail being also much longer than in any of the latter except the Barbary Sheep (*O. lervia*), in which the horns are of a peculiar type. If, as is probable, the long tail be an acquired character, the wild Mouflons or Urials may represent the ancestral stock. A small Sheep with Goat-like horns was domesticated by the Prehistoric Swiss lake-dwellers; and the earliest Egyptian paintings show a domesticated breed of the Barbary Sheep, replaced in those of later date by one with Mouflon-like horns.

The horns are very variable, being sometimes absent in one or both sexes, and in other cases increased to four or more, while in one Himalayan breed they coalesce. In the Wallachian Sheep they assume a more or less upright, corkscrew-like form.

In certain breeds the tail is flattened and the coat hairy, although in the lambs the latter is woolly and affords "Astrachan." In South-western Asia and South Africa the tails of these Sheep are long and heavy, but in the black-headed breed of Persia, Central Asia, Arabia, and North Africa, they are short and rudimentary. The Shiluk Sheep of the Upper Nile have long fat tails and brown hairy coats.

Among the round-tailed breeds, the brown and white Fezzan Sheep have hairy coats. The small Shetland breed also shows some hair mingled with the wool; and in the old small Scotch breed, now nearly extinct, the soft short wool felts badly. In the island of Soa, belonging to the St. Kilda group, is found a small breed of brown-woolled Sheep believed to have been introduced by the Vikings. Four-horned Sheep are found from Iceland to China. There are two breeds of Welsh Sheep, one of which is found in the mountains, and has horns in both sexes, and hair mixed with the wool; while the other occurs in the valleys, and is hornless, with

soft, badly-felting wool. Nearly allied to the Welsh Mountain breed were the Irish Wicklow Sheep before they were altered by crossing. Larger than these are the Kerry Sheep, in which the ewes are frequently hornless, and the fleece is moderately soft and interspersed with hair.

Sheep of the Heath breed, from the mountains and moors of Derbyshire, and the counties to the north, have horns in both sexes, black faces and legs, and a coarse and shaggy fleece. Cheviots are somewhat heavier, with white faces and legs, and moderately fine wool. In the old Norfolk breed the horns of the rams are massive and spiral, the body and limbs long, the face and legs black, and the wool silky and of medium length. The Sheep of Dartmoor and Exmoor exemplify the various Moorland breeds, which are of small size, often with dark or grey faces and limbs, and with or without horns. In the two breeds named, the wool is of medium length, but in other Moorland Sheep it is very short.

In the Southdown breed horns are wanting, the face, ears and legs are blackish brown, and the wool is short, close, and felting. The Dorset and pink-nosed Somerset breeds are long-limbed, horned Sheep, with white faces, ears, and legs, wool of medium length, and the nose frequently flesh-coloured. In the Forest of Dean and the Mendips the Dorsets are represented by a smaller variety ; the Portland breed being also allied, but very small-sized.

Merinos, in which the females are usually hornless, and the face and legs are either white or grey, have very long and fine wool. The other long-woolled breeds in which horns are wanting include the New Leicester, Lincolnshire, Romney Marsh, Cotswold, Devonshire, Nottinghamshire, and the long-woolled Irish. They are all large-sized Sheep, with wool adapted for the manufacture of worsted yarn, but unsuited for felting.

British Breeds. A number of specimens, mainly heads and skulls, represent some of the more striking British breeds. Among them, the Scotch Mountain breed is represented by a wether from Kirkcudbrightshire, presented by Mr. H. Grant in 1900 ; by the skull of a ram from Argyllshire, presented by Mr. A. J. H. Campbell in 1901 ; and by two mounted heads of rams. Of the Norfolk breed there is the head of a ram, from Cambridgeshire, purchased in 1903 ; while the Dorset breed, in which (like the Scotch) both sexes carry horns, is represented by the heads of a ram and of a wether. Other breeds exhibited are Black Welsh, Cotswold, Suffolk, Hampshire Down, Leicester, Shropshire, and Devonshire. In the

Isle of Man, as well as in the Hebrides, Orkneys, etc., occurs a breed of small four-horned Sheep, with brown or black wool. These Sheep are represented in the collection by a ram from the Isle of Man, presented by Mr. G. C. Bacon in 1901 (fig. 10).

Near akin are the aforesaid smaller Soa Sheep, which live in practically a wild state on Soa Island, in the St. Kilda group, and are occasionally, so far as the rams are concerned, four-horned. The collection includes the mounted skin of a ewe and the skull of a ram, both purchased in 1900.

Merinos. The Merino, although practically unknown in this country, is one of the breeds supplying the bulk of the wool-produce of the world at the present day, if, indeed, it does not exceed all other breeds in this respect. Merinos, as their name indicates, were originally a Spanish breed; but in early days the Spanish flocks produced more wool than the factories of the country could work up, and the surplus sheep were sold. In the year 1783, King Louis XVI. of France bought a large estate at the village of Rambouillet, some forty miles west of Paris, where he established an extensive Merino-farm. Other flocks of selected Merinos were subsequently introduced from Spain, with the result that in the course of a century the Rambouillet flock, by careful selection, was developed into a breed of smooth-bodied Sheep remarkable for their large bodily size and the excellence of their wool. The size of the Rambouillet breed is indeed so great that these Merinos have been nick-named 'Elephant-Sheep.' They have the advantage of being much hardier than their Spanish ancestors. Merinos, and especially Rambouillets, have been exported to South Africa, the United States, South America, Australia, New Zealand, etc. The Cape breed appears to be directly derived from the original Spanish stock, and is now the source of the great bulk of the enormous wool-product of that colony. The Rambouillet breed, on the other hand, is extensively kept in France, Germany, Russia, and other parts of the Continent; and has been largely exported to Australia, Argentina, and the United States. In the last-named country the breed now extends from the Atlantic to the Pacific, although pure-bred flocks are limited to certain districts; and in Argentina there are also enormous flocks of choice breeding. The breed is represented in the collection by a fine Merino ram from Cape Colony, presented by the Minister of Agriculture for that Colony in 1906; and also by miniature models of a ram and an ewe, purchased in 1902.

FIG. 7.

ABYSSINIAN MANED SHEEP.

FIG. 8.

WALLACHIAN SHEEP.

To face p. 17.

Bündner Sheep. In the eighty-third volume of the 'Verhandlungen' of the Swiss Naturalists' Society will be found an account of a peculiar breed of Domesticated Sheep with Goat-like horns formerly kept by the natives of the Bünden Oberland, Switzerland, and hence locally known as the 'Bündnerschaf.' The breed is known to be of great antiquity, but appears to be now almost exterminated owing to crossing with other strains. It appears to be nearly related to the so-called Peat-Sheep (Torfschaf) of the Prehistoric Swiss lake-dwellings, of which it is probably the direct descendant. The Crossbred Valais and Bündner Sheep, of which a ram from Graubünden, Switzerland, is exhibited, represent this ancient breed.

Corsican Sheep. These small Sheep, which have long buff wool, with the under-side of the body and the legs black, are represented in the collection by two skulls of rams, one presented by H.H. Prince Roland Bonaparte in 1904, and the other by Dr. C. I. Forsyth Major in 1907.

Hairy Sheep. Two types of Sheep with short tails, hair in place of wool, and the horns small or wanting, occur in Africa. The first, characterised by the smooth coat and long limbs, is the Long-limbed Sheep (*Ovis longipes*). The second, in which the neck and throat are maned, the limbs shorter, and the size smaller, is the Maned Sheep (*O. jubata*, fig. 7). Very generally these sheep are piebald in colour, showing large patches of black or brown on a white ground. In the Long-legged Sheep of Guinea the males have small horns, but in the West Indian breed (imported from Africa) horns are wanting in both sexes. The Camaroons representative of the Maned Sheep appears to be the smallest breed in existence. Limb-bones agreeing in size with those of this breed have been discovered in Wiltshire. It has been assumed that the Long-legged and the Maned Sheep are specifically distinct from the European *Ovis aries*, but this is not certain. The presence of face-glands shows that they are not derived from the Barbary Sheep (*O. lervia*) of North Africa; and as there is no other wild African Sheep, it would seem probable that they are related to the European Mouflon (*O. musimon*).

The West Indian breed is represented by a ram from Barbadoes, presented to the Museum by the Minister of Agriculture for the West Indies. Its most striking features are the uniformly foxy red colour of the coat, and the short and hairy nature of the latter, which displays no tendency to woolliness, and is almost exactly

similar to the summer coat of the wild Mouflon or Urial. The head is, in fact, almost identical in form and general appearance with that of a female of one of those two species, and thus quite different from the long and slender head of the Barbary Wild Sheep, or Udad, which has been regarded as the ancestral stock of the domesticated breeds. The tail is much shorter than in European Domesticated Sheep, not reaching to within a considerable distance of the hocks. From the uniform colour of the coat it would seem probable that the breed is more nearly related to the Urial than to the Mouflon; and if the former were originally domesticated in Persia, it might well have been introduced into Africa by way of Syria. Be that as it may, it seems most likely that in the West African breed we have the earlier stock of the more specialised woolly breeds of Europe.

The Maned breed is represented by a ram from Abyssinia, which has short horns, a brown shaggy coat, and a short tail. The Pigmy breed, from the Camaroons district of West Africa, is shown by a specimen of an adult ram, which stands only 19 inches at the withers. The horns, which are stout and thick, are only about an inch and a half in length, and the coat consists of coarse hair without any trace of wool. On most of the body the hair is about an inch long, but on the neck it is lengthened into a kind of mane, and there is also a ruff on the throat. The general colour of the hair of the upper-parts is chestnut-red, but the ears, the greater part of the face, the throat ruff, the buttocks, the whole of the under-parts, and a large portion of the legs are jet black. The tail is short and thinly haired, not reaching half-way to the hocks. In its black under-parts this sheep presents a remarkable contrast to the wild Mouflon, in which the belly is white with a broad band of black dividing it from the fawn of the flanks. This white belly of the Mouflon is obviously for protective purposes, and with the removal of any necessity for protective coloration in the domesticated breed, it would seem that the black of the flank band has spread over the whole of the under-parts. The shortness of the tail points to affinity with the Mouflon, and also shows that this and the other Hairy Sheep of West Africa have no relationship to the Barbary Wild Sheep.

Hausa Sheep. The Domesticated Sheep of the Hausas of Nigeria form a well-marked breed, which has been named *Ovis longipes carnapi* (fig. 9). The breed is typically characterised by the hairy coat, the drooping ears, 'Roman-nosed' profile, long legs, long short-haired tail, the presence of a pair of pendent lappets,

or tags, of skin on the throat, and the black-and-white, or brown-and-white colouring. The rams carry a pair of long, spirally twisted, and outwardly directed horns, but the ewes are hornless. Typically the ears of the rams hang straight down, while those of the ewes are directed almost horizontally outwards; and the whole of the head (with

FIG. 9.—A HAUSA OR NIGERIAN RAM.
(From the Report of the Royal Zoological Society of Ireland for 1902.)

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The Hunia, or Fighting Sheep of India. The rams of this breed are kept by many of the native princes of India for the purpose of fighting. They are characterised by the convex profile of the face, and the short and deer-like tail, which is quite unlike that of most other domesticated breeds. The horns are not unlike those of the Himalayan Urial, or Wild Sheep. Darwin, in his 'Animals and Plants under Domestication,' makes a quotation from a paper by Brian Hodgson published in the sixteenth volume of the *Journal* of the Asiatic Society of Bengal to the effect that the long tail of the ordinary domesticated breeds of Sheep 'in most of its phases is an instance of degeneracy in these pre-eminently Alpine animals.' He appears, however, to have overlooked the statement in the same paper that Hunia Sheep always have short tails, a fact which suggests that this Hunia breed is nearer the ancestral wild stock of Domesticated Sheep in general than is any other strain. A further inference is that the Urial or Shapo of the Himalaya is very likely to be the ancestral stock of at least some of the domesticated breeds. The Museum possesses a number of skulls and horns of Hunia rams, in which the form of the horns is just what might be expected as the results of domestication of the wild Urial. If the Hunia breed be the direct descendant of the wild Urial, its wool may be regarded as an ultra development of the under-fur or *pashm*, which, as in other Tibetan animals, is very abundant in that species. The strongly arched chaffron or 'Roman nose' of the rams of the Hunia breed is mentioned by Brian Hodgson as another feature due to domestication.

A Hunia Fighting Ram from Baroda, India, was presented by H.H. the Maharaja-Gaikwar of Baroda in 1905, and is exhibited, together with many skulls of rams from Nepal, Simla, and other parts of India, presented by Mr. Brian Hodgson in 1848 and by Mr. A. O. Hume in 1891.

Here may be noticed the skull of a short-tailed ram from the Bahr-el-Ghazal, in the Eastern Sudan, presented by Capt. S. S. Flower in 1904, which apparently indicates a breed allied to the Hunia Sheep.

South African Piebald Sheep. This breed appears to be originally a native of Zululand, but at least half-a-dozen flocks are kept in England. Frequently the rams have only one pair of horns, and their colour is black, with the exception of the face and the tip of the long tail, which are always white. In other cases, as in the specimens exhibited, the rams are four-horned, and

FIG. 10.

FOUR-HORNED HEBRIDEAN RAM.

FIG. 11.

FOUR-HORNED SOUTH AFRICAN PIEBALD RAM.

To face p. 21.

show much more white. The ewes are either hornless, or with a very small pair of horns. The occurrence of Four-horned Sheep in St. Kilda and Uist has been already mentioned, these being characterised by their brownish, or brown and white, fleece, and brown horns. Some of these Hebridean Sheep have been introduced into certain English parks. In the present breed, on the other hand, when the rams have four horns (fig. 11), the upper pair generally curve upwards and backwards in a curiously Goat-like manner. A more important characteristic is that the horns, whether two or four, are invariably black. The fleece and tail are long; and while the middle of the face is white, the rest of the head and body is generally piebald. Wholly black specimens are, however, by no means uncommon.

Sheep of this breed are kept by the following owners, viz.: The Duke of Devonshire, at Chatsworth; Mr. E. C. Lowndes, of Castle Coombe, Chippenham, Wilts; Mr. J. Whitaker, of Rainsworth, Nottinghamshire; Lady Cowley, of Draycot Park, Wilts; Mrs. Farrer, of Ingleborough, Clapham, Yorkshire; Sir H. Dryden, of Canons Ashby, Northamptonshire; and Col. Platt, of Gorddinog, Llanfairfechan, North Wales. The late Duke of Hamilton also possessed a flock in Scotland.

In regard to the native home of these Sheep, there appears to be much uncertainty among owners. It is, however, certain that they do not come from either St. Kilda or Uist. Perhaps the most satisfactory history exists in the case of the flock owned by Mrs. Farrer. The original parents of these Sheep were brought home from the Cape about a century ago by the present owner's grandfather, Col. Farrer, who believed that they had been imported into the Cape by Spanish or Portuguese settlers, who were supposed to have brought them from their own country. A portion of this original flock was given to Sir Henry Dryden's ancestor, so that the Ingleborough and Canons Ashby flocks have the same ancestry.

Lady Cowley's flock was imported at the time of the last Zulu War, about twenty-five years ago, and consisted of about thirty head. These were small, wholly black, two-horned Sheep, with moderately long wool and long tails. A few of these black 'Zulus' were given by Lady Cowley to Mr. Lowndes, and these were subsequently crossed with piebald two-horned rams from the flocks of Mr. Whitaker and Sir H. Dryden, with the result that the breed was greatly improved in size and stamina, while the rams frequently developed a second pair of horns. That the small black 'Zulus' and the larger piebald breed are identical, or nearly so, is rendered

probable by the fact that the former are not unfrequently four-horned, and also from the circumstance that the Museum possesses the head (presented in 1901 by the Rev. H. G. Morse) of a South African Sheep which is black, with a white face, and has four horns. It is noteworthy that in this head the horns are much smaller than in the English piebald rams, and also that the coat is short and hairy.

It is thus evident that wholly black Sheep, and black Sheep with a large white 'blaze' on the face, occur in Zululand and other parts of South Africa, and also that the rams of these Sheep are not unfrequently four-horned. On the other hand there seems no information with regard to the existence of any such breed either in Spain, Portugal, or North Africa. Consequently, till the contrary is proved, the presumption is that these Sheep are indigenous to South Africa.

The superior size, the longer fleece, and perhaps the greater amount of white on the body in the English strain are features which might naturally occur as the result of better feeding.

That the duplication of the horns in these breeds is due to splitting of the normal pair, is rendered practically certain by a skull of a South African piebald ram presented to the Museum by Mr. W. P. Pycraft. In this specimen each horn is cleft to within a short distance of its base; the minor branch, which is inferior in position, lying close alongside the larger.

The specimens of this breed include a ram, presented by Mr. E. C. Lowndes in 1902; the head of a ram, presented by the Duke of Devonshire in the same year; and the above-mentioned head from South Africa, presented by the Rev. H. G. Morse in 1901.

Unicorn Sheep.

Unicorn Sheep, which are natives of Nepal, take their name from the circumstance that the horns of the rams are completely welded together (fig. 6). The ewes are hornless. The fleece is woolly; the head and neck being black, the body white, and the limbs piebald; the tail appears to be naturally short. These Sheep form a regular breed in Nepal, and are not merely accidental sports. In the adult rams the horns, alike in shape, direction and size, are not dissimilar to those of the Nilgiri Tahr (*Hemitragus hylocrius*); but they are placed so close together that their inner surfaces become practically united, although a transverse section shows that the sheath of each is complete and distinct. From their direct backward curvature, the horns tend to grow into the back of the neck of the animal, so that, as in two skulls in the Museum, it is frequently necessary to saw off the tips.

The ram exhibited was brought home from India by H.R.H. the Prince of Wales in 1906, and exhibited in the Zoological Society's Menagerie, where it died in 1908, when the skin was presented to the Museum by the Council of the Society. The two skulls exhibited were presented to the Museum by Mr. Brian Hodgson in 1848.

Wallachian Sheep. Among the numerous domesticated breeds of Sheep departing more or less widely from the type of the wild Mouflon and the Urial perhaps the most remarkable is the one commonly known in this country as the Wallachian Sheep, and in Germany as the 'Zackelschaf' (fig. 8). In the typical breed, which appears to have its home in Wallachia and Rumania and some of the adjacent countries of Eastern Europe, the horns, which are of great length, are twisted into close straight spirals, rising from the head with but little outward divergence. This type is shown in a miniature model exhibited among the collection, and in the general form of the horns presents a marked superficial resemblance to the Suleiman race of the Markhor Wild Goat, so much so, indeed, as to have led to the suggestion that the Wallachian Sheep originated from a cross between the last-named species and an ordinary Sheep. In a second breed, apparently a native of Hungary, the horns, although of the same general type, are somewhat more divergent and have the spiral rather more open. So different are Wallachian Sheep from the ordinary type that Linnæus regarded them as specifically distinct from the latter (*Ovis aries*), and gave them a separate name, *Ovis strepsiceros*. Certain horns of the Indian Hunia Ram presented to the Museum by Mr. A. O. Hume indicate that there must be a transitional form between the Wallachian and the ordinary Sheep in the matter of horns ; for in these Hunia Rams, although the ordinary 'ammon-spiral' is preserved, the horns are extended much more laterally outwards than usual, and at the same time display a more corkscrew-like type of spiral. The intermediate link seems to be formed by a Hungarian breed in which the horns diverge almost directly outwards in a very open spiral, which is, however, merely an exaggeration of the ordinary Sheep spiral. They are, in fact, almost exactly intermediate between those of the Hunia ram and those of the Hungarian variety of the 'Zackelschaf,' which should therefore be relegated to the rank of a sub-species, or breed of *Ovis aries*, as *Ovis aries strepsiceros*.

The Wallachian Sheep is represented in the collection by a mounted male from Wallachia, purchased in 1903 ; and also by a miniature model of a male of the Hungarian breed, purchased in 1902. In

addition to these, the collection includes the horns of a male and a female from Wallachia, purchased in 1902.

Fat-Tailed Sheep. The African Fat-tailed Sheep (fig. 12), of which a fine example is exhibited, is one of the most remarkable breeds in the world, the tail being of great length and also of excessive width at the base. In the specimen exhibited it is considerably over a yard in length, and in life must have weighed several pounds. Fat-tailed Sheep are met with in many parts of the world, but in few of them is the fatness of the caudal appendage so strongly marked as in the South African breed. This appears to be due to that breed, according to the general belief, being the result of a cross between the Persian Fat-tailed and the African Fat-rumped Sheep. It is to the latter breed that the African Fat-tailed Sheep apparently owes the excessive development of the basal portion of the appendage from which it takes its name. The specimen exhibited of the Cape Fat-tailed breed is a ram from Cape Colony, presented by the Director of Agriculture, Cape Colony, in 1906.

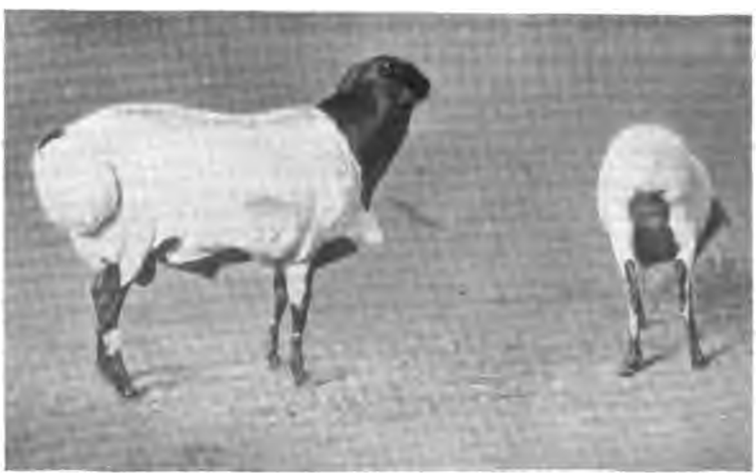
Fat-Rumped Sheep. In the countries to the east and south of the Caspian Sea, such as many parts of Central Asia, Arabia, Persia, and North-eastern Africa, occur certain breeds of Sheep characterised by the tail (which is of the flattened type of that of the Fat-tailed breed) being short or rudimentary, and by the accumulation of large masses of fat on the buttocks (whence the name *Ovis steatopyga*, which has been applied to these Sheep). In the exhibited Arabian breed (fig. 13) the head is black and the body and legs are white, while the coat of the adult is hairy. The lambs have, however, a woolly coat, as have the adults of the Abyssinian breed. In Central Asia both a black and a white strain are kept; the lambs of the former yielding the finely curled wool known as Astrachan. These Sheep are represented in the collection by a ram from Hedjaz, Arabia, presented by Capt. S. S. Flower in 1902.

Domesticated Goats. Domesticated Goats differ from Sheep by the absence of a gland on the face (the 'larmier,' or tear-gland) below each eye, and the presence of a beard on the chin of the male, or sometimes of both sexes. Rams also lack the strong odour of he-Goats. Sheep have interdigital glands between the hoofs of all the feet, but in Goats such glands are wanting in the hind-feet, and may be also absent in the front pair. The horns of Sheep (when present) generally form a close horizontally-directed spiral, with numerous fine transverse wrinkles,

Fig. 12.

SOUTH AFRICAN FAT-TAILED SHEEP.

Fig. 13.



HEDJAZ FAT-RUMPED SHEEP.

[From a photograph by Captain S. S. Flower.]

To face p. 24.

and are brown in colour. Those of Goats are usually blackish, directed more upwards, and may be either scimitar-shaped or cork-screw-like. The Wallachian Sheep has, however, upwardly-directed, corkscrew-like horns. The skull of a typical Goat differs from that of a typical Sheep by the absence of a pit for the face-gland, by the circumstance that the part behind the horns is rounded instead of flat, and meets the frontal plane at a very obtuse, instead of nearly at a right angle, and by the more concave profile of the forehead. There are, however, hornless Roman-nosed Domesticated Goats without a beard, and Wild Sheep without face-glands, so that it is difficult to distinguish between all the members of the two groups. Most Domesticated Goats (*Capra hircus*) are descended from the Wild Goat (*C. hircus ægagrus*) of the Mediterranean Isles, Asia Minor, and Persia, although some may have been crossed with other species. The ears may be upright or pendent, and both sexes may be bearded. When present, the horns are often of the scimitar-like form of the wild species, but generally with the tips turned outwards instead of inwards; they may, however, be spiral like those of the Markhor Wild Goat (*C. falconeri*) of the Himalaya, although nearly always twisted the opposite way. The Circassian Goat has, however, the spiral running in the same direction as that of the Markhor.

Goats were domesticated by the Prehistoric Swiss lake-dwellers and the ancient Egyptians. The Angora breed is large, with spiral horns, long silky white hair, and pendent ears. The Shawl-Goats of Tibet are somewhat smaller, with under-fur, or *pashm*, at the roots of the long hair. Another long-haired breed is the Syrian or Mambar Goat, which is tall and long-limbed, with very long ears, and shaggy silky black hair. In the Egyptian Goat the limbs are long, the horns short or wanting, the head small, with a convex profile, and the beard generally absent; the short hair is usually reddish brown, tending to yellow on the limbs, but may be slaty grey or spotted. In the Sudan breed the horns do not exceed four inches in length, and curve forward at the tips, the limbs being short and stout. The short and thick hair is usually a mixture of black and reddish; but red, yellowish, brown, black, and spotted examples occur. The black beard reaches the chest, where it divides to spread over the shoulders. The range of this breed extends from the Nile valley to the West Coast of Africa.

In many parts of the world Domesticated Goats have reverted to a wild or half-wild (feral) condition, as in Scotland, and the islands of Skye, St. Helena, and Juan Fernandez.

The following list includes the more important of the specimens exhibited.

The English Goat is represented by the head of a female, 'White Queen,' a first prize winner, presented by Mr. R. Walter in 1901; while of the Anglo-Swiss breed a complete female specimen, 'the Black Arrow,' presented by Mr. H. Greenway in 1901, is shown. Of the Goats that have reverted to a wild state, there is the head of a male with black hair from Scotland, presented by Mr. Cecil Grenfell in 1897; and also two heads of the white variety from Skye, presented by Sir Donald Currie, K.C.M.G.

The Tibetan Shawl-Goat is represented by the horns of a male from Ladak, presented by Gen. Strachey in 1879; and likewise by skulls given by Mr. Brian Hodgson in 1848. To the last-named donor the collection owes the skull and horns of a male of the Circassian Goat; while a second specimen of the same, from Turkey, was presented by Capt. S. S. Flower in 1904. Both these show the reversal of the spiral, as compared with ordinary Goats.

For many years a report was current as to the existence of an 'Antelope-like' Wild Goat in the mountains of the Azores. Thanks to Major Chaves, of the Ponte Delgada Museum, the collection now includes a pair of male skulls with horns, which prove that the animal is a true Goat, probably the descendant of domesticated breeds which have run wild. The horns, which are about a couple of feet in length in both skulls, are, however, remarkably straight and upright, their inner edges being almost in contact in one example for a distance of about 8 inches, although they diverge lower down, while in both they assume the open spiral characteristic of Goats generally towards the tips. It is this unusual uprightness and straightness of the horns that led to the idea that the Azores Wild Goat had an affinity to Antelopes.

A male of the Joura Goat, from the Isle of Joura, received from the Zoological Society in 1903, shows that the markings of this breed closely resemble those of the wild *Capra hircus ægagrus*, which formerly inhabited many of the islands of the Ægean Archipelago, and is still found in Crete, Asia Minor, Persia, etc. The skull of a male Goat from Grand Comoro Island, Mozambique Channel, presented by Sir John Kirk, K.C.B., in 1871, is of interest as showing the wide range of breeds nearly related to those of Europe. Much the same may be stated with regard to a female Bornean Domesticated Goat from Sarawak, Borneo, sent home by Dr. C. Hose in 1903. Of the Angora Goat, the collection includes a fine male specimen from Constantinople, presented by Mr. J. E. Whittall in 1901; and

likewise a skull and a head of a male, also from Constantinople, presented by Messrs. J. Foster in 1902.

The Egyptian, often known as the Theban, or Roman-nosed, Goat has been regarded as a Sheep, but since it presents most of the characteristics of the Goats, may be referred to that group. It is an extremely ancient breed, being represented in the Egyptian frescoes at Beni-Hassan. Of this breed the Museum possesses the mounted skin and skeleton of a male from Egypt, purchased in 1900; and likewise the skull of a male from the Eastern Sudan, presented by Capt. S. S. Flower in 1902. The skeleton of a Chinese Hornless Goat from Shanghai, received from the Zoological Society in 1858, appears to indicate a closely allied breed. On the other hand, the skull of an ancient Egyptian Goat, from a tomb in Egypt, presented by Prof. W. Flinders Petrie in 1900, belongs to a totally distinct breed, with well-developed horns. The skull of a female Goat from Khartum, presented by Capt. S. S. Flower in 1903, represents the Sudan breed.

Pigs. The collection of Domesticated Pigs is at present very small, consisting mainly of a few heads, skulls, and models of some of the chief British breeds. Included in the series is a specimen of the Wild Boar (*Sus scrofa*), bred in Windsor Forest, as representing the original ancestral stock of the European breeds of Domesticated Swine. This specimen was presented by H.M. the King in 1901. Here it may be mentioned that the young of wild Swine are striped, although those of domesticated breeds are for the most part without such markings. It is stated, however, that in Hungary there are Domesticated Pigs which produce striped young. Of Domesticated Swine the collection included mounted heads of boars of the brown Tamworth, black Berkshire, and white Yorkshire breeds, all presented by Messrs. C. & T. Harris & Co. There are also miniature models of a white Yorkshire boar and sow, purchased in 1902, as well as a skull of a white Yorkshire boar, presented by Messrs. Harris in 1903. A few other skulls are also exhibited.

In the same case are shown lower jaws of boars from New Guinea in which the tusks are abnormally developed owing to the upper ones having been broken off. These were purchased in 1903. Near by are shown similar tusks of boars from the Fiji Islands. Both in New Guinea and in Fiji, where they are worn as armlets, it is the custom to produce lower tusks of this abnormal form by the removal at an early age of the upper ones. One specimen, forming a complete circle, was presented by Mr. R. T. Pritchett in 1889, the other by Sir William McGregor, K.C.M.G., in 1886.

Llama and Alpaca. Previous to the conquest of South America by the Spaniards, the Llama and Alpaca, which are descended from the Wild Guanaco (*Lama huanacus*) of Patagonia, were the only large domesticated animals on that continent, and were fully as important to the Peruvians as is the Reindeer to the modern Lapps. Not only did they perform all the carrying work of the country, but they furnished food and wool. The Llama is the larger of the two breeds, and is variable in colour, although generally white, or white blotched with black or brown, the hair being comparatively short. The males were alone employed to carry burdens; the females supplying milk and flesh. The Alpaca is a smaller and much longer-haired animal, which was bred solely for the sake of its wool. The usual colour is very dark brown or black; and in many examples the hair of the body is so long as almost to touch the ground. The number of Llamas employed by the ancient Peruvians to transport the produce of the Potosi Mines has been estimated at 300,000. The flesh is said to rival the best mutton in quality. Llamas, inclusive of the Guanaco, are the South American representatives of the Camels of the Old World, although they have no humps. Before they were introduced by Europeans, South America had no Cattle, Sheep or Goats. Specimens of the Llama are shown in the North Hall.

Domesticated Dogs. From the structure of the frontal region of the skull it is evident that Domesticated Dogs (*Canis familiaris*) are derived from wild species related to the Wolf (*Canis lupus*), the North American Coyoté (*C. latrans*), and the Jackal (*C. aureus*), and have no near kinship to the Fox (*Vulpes alopex*). The skulls of the Coyoté and Fox exhibited in the table-case of skulls show, for instance, that in the former the postorbital process of the frontal bone (X) is convex, as in Domesticated Dogs, whereas in the latter it is concave. Whether Domesticated Dogs are derived from Wolves and Jackals, or from one or more extinct species, is uncertain. From the superficial formations of Russia have been obtained the remains of a Dog (*Canis pontiatini*) which, it is suggested, may have been the ancestor of Sheep-dogs and Hounds, and, by crossing with the Wolf, of Mastiffs and Deerhounds. It has, however, to be determined whether this fossil species, which appears to have been nearly related to the Australian Dingo, was really wild. Terriers, Pomeranians, etc., have been regarded as descendants of *Canis familiaris palustris*, of the Bronze period, the latter being a derivative from

Canis mickii, the remains of which occur in somewhat earlier strata on the Continent.

The number of lower teeth in domesticated breeds is greater than in the Asiatic Wild Dogs of the genus *Cyon*. Eskimo Dogs present many Wolf-like characters, and the Dogs of the Hare Indians show a strong resemblance to the Coyoté. In Europe Dogs were domesticated during the Prehistoric period ; and in Egypt several distinct breeds were established between 3,000 and 4,000 B.C.

The greater number of the breeds may be arranged in the following six groups :—

I.—WOLF-LIKE DOGS. Including Eskimo and Hare Indian Dogs, Pomeranians, Sheep-dogs and Collies, Drovers' Dogs, and the Pariah Dogs of Eastern Europe, Asia, and Africa. The Dingo, which is domesticated by the Australian aborigines, has been generally regarded as a distinct species, but comes very close to the Pariah Dogs.

II.—GREYHOUND GROUP. Comprising English and Italian Greyhounds, Deerhound, Irish Wolfhound, and Persian, Afghan, and Russian long-haired Greyhounds or Wolfhounds, the last now generally known as Borzois. These Dogs hunt by sight. The Hairless Dogs of Asia and South America may probably be placed here. Lurchers are a cross between either the Deerhound and Collie or the English Greyhound and Sheep-dog.

III.—SPANIEL GROUP. Includes Field and Water Spaniels, of which there are several breeds, King Charles, Blenheim, Pekinese and Japanese Spaniels, Setters (large Spaniels which point at game), Retrievers, Newfoundlands, and Labrador Dogs.

IV.—HOUND GROUP. In this group are classed Bloodhounds, Staghounds, Foxhounds, Harriers, Otter-hounds, Beagles, Bassets, Turnspits, Dachshunds, Pointers, and Dalmatian or Carriage Dogs. With the exception of the Pointer, the members of this group hunt by foot-scent.

V.—MASTIFF GROUP. Includes English and Cuban Mastiffs, Bull-dog, Great Danes or Boarhounds, Pugs, St. Bernards, and the long-haired Tibetan Mastiff. The Bull-terrier is a cross between the Bull-dog and the Smooth-haired Terrier.

VI.—TERRIER GROUP. Comprises Fox-terriers, Irish Terrier, Skye Terrier, Dandie Dinmont, Yorkshire and Halifax Terriers, English Terrier, Poodles, and Maltese, Russian, and Mexican Lapdogs.

Pariahs and Dingo.

In addition to a large number of skulls exhibited in the table-case, Pariah Dogs are represented in the collection by a female from Constantinople, presented

by the Duchess of Bedford in 1907 (fig. 14); by a male from Egypt, presented by the Hon. Walter Rothschild in 1904; and by a male and female (of which the former is grey and the latter red) from India, which were purchased in 1903. It will be noticed that in general character these Pariah Dogs come very close to the Dingo, the Domesticated Dog of the Australian aborigines, of which a specimen, presented by the Zoological Society in 1901, is exhibited. Although long regarded as an indigenous species, there is little doubt that the Dingo was brought to Australia by the natives on their first arrival.

Eskimo Dog. Eskimo Dogs, like the Samoyede breed of Siberia, are closely allied to the larger variety of the Pomeranian or Spitz; and in some cases it is difficult to distinguish between the two. Eskimo Dogs are represented in the collection by 'Farthest North,' a dog which formed the leader in the team of Lieut. Peary during his expedition to Greenland. This famous dog, which died in April, 1902, was bred in Greenland, and presented by Miss Casella. Another well-known Eskimo of which the mounted skin is shown is 'Seymour-Franklin,' a female prize-winner, which was born in May, 1888, and died in 1900 (K.C.S.B., No. 30,393). This dog was bred in England by Mr. W. K. Taunton, and presented by him on its death. A third celebrated Eskimo is 'Arctic King,' which was born in England July 1st, 1902, and died May 1st, 1904. This dog was the winner of more than 120 first and special prizes. Its mounted skeleton was presented by Mr. A. P. King in 1907. A fourth specimen of the Eskimo breed, a female from Greenland, was presented by Mr. W. K. Taunton in 1900.

'Chow-Chow.' Near akin to the Eskimo is the Chinese breed known in this country as 'Chow-Chow,' a 'Pigeon-English' term meaning to eat, in allusion to the fact that these Dogs are commonly used for food in China. The first specimen is a male Black Chow-Chow, which was born in March 1892, and died February, 1902. This dog (K.C.S.B., No. 37,905, fig. 15), which was the winner of 6 first and several second prizes and medals, was bred in France by M. Waldeck-Rousseau, and presented by Miss Casella in 1902. The Red Chow-Chow is represented in the collection by the head of Champion 'T'ien,' a female (K.C.S.B., No. 1720A), born in England, May, 1895, which died in August, 1903, and was presented by the breeder, Miss Casella, in the same year.

Sheep Dog. The old English (Bob-tailed) Sheep-dog is a breed which appears to be of great antiquity, and remarkable for the fact that a considerable proportion of the pups are born

Fig. 14.

TURKISH PARIAH DOG.

Fig. 15.

CHINESE DOG, OR 'CHOW-CHOW.'

To face p. 30.

with quite short tails, apparently an instance of inheritance of an acquired character. The one example of this breed in the collection is the Champion female 'Fair Weather,' which was born in May, 1898, and died in August, 1907; her sire being 'Sir James,' and her dam, 'Birthday.' She was the most celebrated Sheep-dog of her time, and the winner of a very large number of first and special prizes, cups, championships, etc. The specimen was presented by the breeder and owner, Mrs. Fare Forse, in 1907.

Collie, or Scotch Sheep-Dog. The name by which this breed is commonly known in England is corrupted from 'Colly,' which means black-faced, and was originally applied to Highland Sheep instead of to the Dog by which they are tended. Collies of much the same type as the present rough-haired breed were in use in the sixteenth century, and there is little doubt that these Dogs are of a very ancient type. The Rough-coated Collie is represented by 'Roy' (sire 'Trentham Roy,' dam, 'Portington Lassie'), who was born in October, 1896, and died in February, 1904. The breeder was Mr. A. P. Attawell, and the specimen was presented by Mr. F. Stephenson in 1905.

Greyhounds. Greyhounds are built essentially for speed, and specially characterised by their habit of hunting by sight instead of by scent. Coursing existed as a sport in the second century, and the Greyhounds of that period were probably not very unlike the modern breed, although heavier. Greyhounds are represented in Greek and Roman sculptures; and Greyhound-like Dogs were also known to the ancient Egyptians, by whom they were employed in coursing, but whether they hunted by sight or by scent cannot be determined. Some of these ancient Egyptian Hounds resembled modern Greyhounds in general characters, although apparently with shorter legs, but others were more like Borzois, and one (fig. 17) is identical with the Slughi, or Persian Greyhound. Previously to the time of Queen Elizabeth Greyhounds seem to have been larger and more powerful than the modern breed, showing some approximation to Deerhounds, and being employed for hunting deer as well as hares; and it was only after they were used exclusively for coursing hares that the modern type was developed.

The Whippet is a smaller dog, apparently the product of a cross between the Greyhound and a Terrier; while the Italian Greyhound is a diminutive breed. Nearly allied to the true Greyhound is the hairy Persian Greyhound, which leads on to the Afghan Greyhound, the Borzoi, or Russian Wolfhound, the Scotch Deerhound, and the modern representative of the Irish Wolfhound, some of these breeds hunting

as much by scent as by sight. The Lurcher is probably derived from a cross between the Deerhound and the old Talbot Hound.

The English Greyhound is represented by 'Fullerton' (fig. 16), a Dog, born in 1888, who was winner of the Waterloo Cup in 1889, 1890, 1891 and 1892. He was bred by Mr. J. Dent, and sold as a pup for 850 guineas to Col. North. The skin and skeleton were presented by Sir W. J. Ingram, Bart., in 1899, the year in which this famous Dog died. 'Fullerton' is considered to have been the best

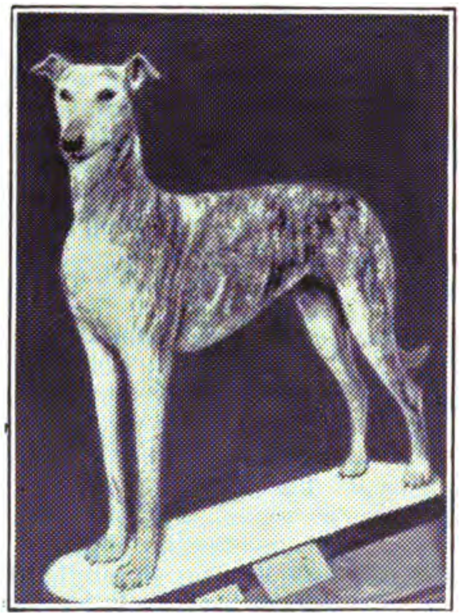
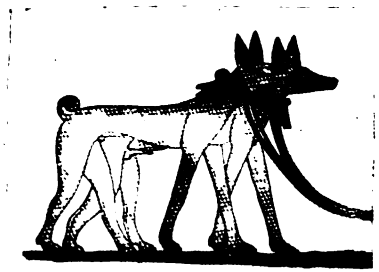


Fig. 16.—English Greyhound 'Fullerton.'

Greyhound ever bred. The breed is also represented by the head and skeleton of 'Champion Fairy,' a female which died in May, 1903. These specimens were presented by Mr. J. J. Holgate, the breeder, in 1903. The collection also includes the skeleton of a so-called Australian Greyhound, this being merely the English breed acclimatised in Australia. The Italian Greyhound is at present represented only by the skull of 'Cato,' presented by Miss H. M. Mackenzie in 1902. Here may be placed the Hairless Dogs, of which an English-bred specimen, presented by Mrs. Whitbread in 1903, is exhibited.

Fig. 17.



ANCIENT EGYPTIAN GREY-HOUND, OR ZELUGHI.

Fig. 19.

MOLOSSIAN DOG, FROM AN ASSYRIAN BASSO-RELIEVO.

Fig. 18.

(*A*) SLUGHI, 'LUMAN.' (*B*) AFGHAN GREYHOUND, 'SHAHZADA.'

To face p. 33.

Slughi. The Slughi, or Gazelle-Hound, is one of the oldest breeds of Dogs, being represented (under the name of Zelughi) in the frescoes on the tombs of Beni-Hasan, in the valley of the Nile, Egypt (fig. 17). A copy of one of these paintings is shown in the wall-case on the north side of the Hall. The true Slughi is kept by the tribes of the Eastern deserts, the finest strain being in the possession of the Bedouin chiefs. The breed is also known as the Syrian or Persian Greyhound, although short-haired Dogs are likewise included under the former name. These Dogs are used for hunting gazelles, hares, etc.; often with the assistance of falcons, which fly at the head of the quarry. They are bred to match the desert sand in colour, their tint ranging from rufous fawn to dirty white. In the collection the Slughi is represented by 'Luman' (fig. 18, A), who died in 1907 at the age of 11½ years. This Dog was imported as a puppy from the chief of the Tahawi tribe, Lower Egypt. In its prime it had bright golden-yellow hair, passing into deep cream-colour on the face, limbs, under-parts, and the middle of the tail. At the time of its death the face had, however, turned white, and the ears had lost much of their fringe of long hair. The specimen was presented by the Hon. Florence Amherst in 1907.

Afghan Greyhound. The Afghan Greyhound not improbably represents very nearly the primitive ancestral type from which modern Borzois, Deerhounds, and Greyhounds are descended. The breed is native to Balk, in North-eastern Afghanistan, and belongs to the Sirdars of the Barakhzy family. These Dogs hunt in couples—male and female—and are of high courage. 'Shahzada,' the Dog exhibited (fig. 18, B), was the most typical specimen of the breed in his time in Europe; and as these Dogs are owned by native chiefs, it is difficult to secure good examples. 'Shahzada' was a fine, upstanding hound, reddish-fawn—almost wheaten—in colour. The body is covered with a profusion of soft, golden-coloured hair extending over the ears, shoulders, and half-way down the legs, the lower half of the latter being bare of long hair although the toes are heavily feathered. 'Zardin,' another famous Dog of this breed, of which a picture is exhibited, differs in carrying a greater profusion of coat, and in being creamy rather than golden or reddish fawn in colour, the long hair extending down the legs. 'Zardin' also has a tuft of hair on the head, which is otherwise smooth, as in 'Shahzada.' He stood at least 26 inches at the shoulder; and was brought from Seistan, in Eastern Persia, to Quetta, where he was shown before being imported to England. Nothing is known about

his pedigree or breeder, but he was believed to be five years old when the portrait was taken. In some respects the Afghan resembles the Persian Greyhound, the last-named being, however, less shaggy. 'Shahzada' died in February, 1901, and 'Mooroo,' the female exhibited, in 1903. Both came from Balk, in Afghanistan, and were presented by Mrs. Whitbread.

Borzois. Borzois, or Russian Wolfhounds, are represented in the collection, firstly by 'Count Ivan' (K.C.S.B., No. 515E), who was born July 10th, 1898, died in 1902, his sire being 'Prince Galitzin,' and his dam 'Lady Banga.' This Dog was bred by Mr. J. B. Dixon; and presented by Mr. G. Pauling in 1906. The second example is 'Wilna' (K.C.S.B., No. 534E), a Borzoi bred by the Duchess of Newcastle, and owned by the Duchess of Cleveland. Born in 1897, this Dog died in 1903, in which year the skin was presented by Mr. F. H. Collings. The collection also contains the skeleton of the Borzoi 'Alex,' a son of H.M. the Queen's 'Champion Alex,' presented by Mr. F. W. G. Walker in 1905.

Irish Wolfhound and Deerhound. The Irish Wolfhound had become practically extinct, but has been revived by careful breeding and selection, so that its modern representatives are stated to be very similar to the original type. The modern breed is represented by the skull and mounted skin of 'O'Leary,' a male born in March, 1896, who died in February, 1902. He was bred in England by Mr. G. E. Crisp, who presented the skin and skull. There are also the skulls of a male and female Irish Wolfhound, presented by Capt. G. A. Graham in 1882.

The Scotch Deerhound is represented by 'Marquis of Lorne' (K.C.S.B., No. 33,118), who was born in November, 1891, and died in February, 1903. Bred by Mr. R. H. Westley, 'Marquis of Lorne' was the winner of 30 prizes, including 11 firsts and 7 specials. The skin and skull were presented by Mr. Westley in 1903. Besides this, the Museum possesses the skeleton of another celebrated Scotch Deerhound, 'Champion Rufford Bend'Or.' This Dog, which was born in February, 1896, and died in October, 1902, was bred by Messrs. Holme and Holliday, and was the winner of 50 prizes, including a first prize at Birmingham in 1900, 10 first and challenge prizes in 1901, and 5 in 1902. The skeleton was presented by Mr. F. L. Armstrong in 1902.

Toy Spaniels. Although specimens of the larger breeds of Spaniels are wanting, the collection includes a number of examples of various breeds of Toy Spaniels. Of the Ruby King

Charles Spaniel, the first specimen is 'Sweet English Rose,' which was born on April 23, 1902, and died on June 23, 1903, her sire being 'Young England,' and her dam 'Sweetheart.' She was the winner of 7 first prizes, 2 challenge-cups, 1 championship, and several special prizes. This Dog was bred and presented by Mrs. Kate Stephens. To the same donor belonged 'Solent Duchess,' another specimen of the same breed, which was born on March 16th, 1903, and died on June 23rd, 1906, her sire being 'Superb,' and her dam 'Solent Queen.' This dog won 4 first prizes, 1 challenge-cup, 2 championships, and several special prizes. She was bred by Miss Davies. The Black and Tan breed of King Charles Spaniel is represented by 'Harford Defender' (K.C.S.B., 1719H), whose sire was Champion 'Defender' (K.C.S.B., No. 660A), and dam 'Harford Minnie' (K.C.S.B., No. 1714H). This Dog, which was born in December, 1900, and died in November, 1905, was bred by Mr. F. W. Lewis, of Haverfordwest, and was the winner of first prizes at the Birmingham, Botanical Gardens, Richmond, and Ealing Shows in 1903 and 1904. The specimen was presented by Mrs. Gilpin in 1905. A second representative of the same breed is Champion 'Bend-Or' (K.C.S.B., No. 15,678), who was born in May, 1882, and died about 1896, his sire being 'Victor,' and his dam unnamed. Bred by Mrs. J. A. Bugg, this Dog was presented by the owner, Mrs. Jack Reid, in 1906. Of Blenheim Spaniels 'Rose,' born about 1847, and presented by Mrs. Coe in 1904, is of much interest, as showing the characters of the breed at the middle of the 19th century. 'Chesham Silvio,' who died in October, 1904, shows the modern type of the breed: this specimen was presented by Mrs. J. Hill in 1904. An immature male of the same breed, which was born on June 25th, 1905, and died on April 20th, 1906, is also shown. The sire was 'Little Mafeking,' and the dam 'Chesham Minette.' This puppy was bred by Mrs. J. Hill, and presented by Mr. E. Langstone in 1906. Another male Blenheim Spaniel puppy, which was born on September 11th, 1904, and died eight weeks later (sire Champion 'The Cherub,' dam 'Juniper'), is of interest on account of being considered to be the shortest-headed puppy of this breed ever produced. It was bred and presented by Mrs. Gilpin.

Of Asiatic breeds the Pekinese Spaniel is represented by 'Ah Cam,' a male, and the winner of the champion prize in 1904. He was imported from Pekin in 1896, when about one year old, and died in England on January 1st, 1905. The specimen was presented by Mr. T. Douglas Murray in 1906. The collection also includes the mounted skin of 'Palace Yo Tei,' one of the best Pekinese dogs ever shown in this country, which was presented by its late owner,

Mrs. Vallance, of Aymers, Sittingbourne. 'Yo Tei' was a granddaughter—through both sire and dam—of 'Ah cam,' and, although rather less than four years old at the time of her death, carried off eight first prizes and a bronze medal. Of the Chinchilla Pekinese

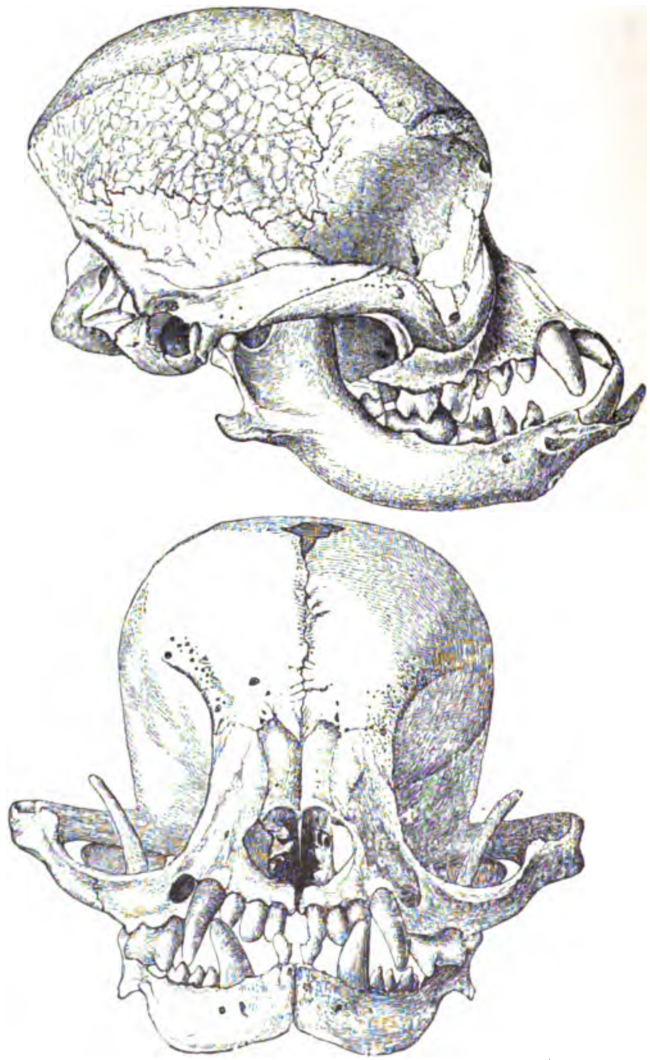


FIG. 20.—SIDE AND FRONT VIEWS OF THE SKULL OF THE PEKINESE SPANIEL. (From the Zoological Society's *Proceedings* for 1867.)

Spaniel, the Museum possesses 'Sutherland Kia-Mi,' which was born on October 23rd, 1906, and died on May 3rd, 1907, his sire being 'Sutherland Ouen-ten T'ang,' and his dam 'Sutherland Pou-gee.' The specimen was presented by the owner, Mrs. F. M. Weaver. Japanese Spaniels are represented firstly by a male bred in Japan, and imported to France in 1902, where it died in 1905. This Dog, supposed to be the finest example of its kind in Europe, was presented by Sir W. Ingram, Bart., in 1905. Another Japanese Spaniel, bred in England, was presented by Mrs. Whitbred in 1903; and there is a third example of the breed, the gift of Mr. Rowland Ward. The collection also includes the skeleton of a Japanese Spaniel, presented by Miss Saunders. Figure 20 shows the curiously shortened skull of the Pekin breed.

Here may be mentioned the skull of an ancient Egyptian Dog of the Spaniel type, from a tomb in Egypt, presented by Professor W. Flinders Petrie in 1900.

Newfoundland and Labrador. These two breeds are represented by a Black and White Newfoundland, bred in England, and purchased in 1901; and by a Labrador Dog, presented by Mr. Rowland Ward in 1901.

Bloodhound, or Sleuthhound. Bloodhounds were known in England at least as early as 1570, and may be the same as the Lemor, or Lymer, which was in existence in 1486. Although some authorities dispute such a pedigree, the Bloodhound is commonly believed to be derived from the Talbot (the ancestor of the true Hounds), and thus from the St. Hubert of the Ardennes. The latter dates from very early times, certainly from those of the Gauls. In the eighth century it was called the Flemish Hound, of which there were two strains known as the black (black-and-tan) and the white. St. Huberts were brought to England at the Conquest, and again in the time of James I. They were deep-voiced Dogs, with great powers of scent. These two features are characteristic of the modern Bloodhound, which differs somewhat in appearance from its immediate ancestors.

The Bloodhound is essentially a large black-and-tan Hound, distinguished by its enormous pendent ears, wrinkled forehead, sunken eyes, showing a lozenge-shaped inner exposure of the lids, deep drooping lips or 'flews,' and large dewlap. The power of tracking by scent is very acute, the voice deep and baying, and the disposition gentle and affectionate. The first specimen is the champion female English Bloodhound, 'Chatley Brilliant' (K.C.S.B.,

No. 236B.), who was born in July, 1898, and died June 6th, 1903, her sire being 'Chatley Bellman,' and her dam 'Chatley Chantress'; she was the winner of many first and championship prizes. The skin was presented by the breeder and owner, Mr. Oliphant, in 1903. To the same donor the Museum is indebted for 'Chatley Blazer,' own brother to 'Chatley Brilliant,' who died in November, 1905, and who was winner of the first prize at the Crystal Palace in 1903, as well as of other prizes.

Next comes the head of the male English Bloodhound Champion 'Babbo' (K.C.S.B., No. 96,472A), a Dog born in April, 1896. He died in October, 1901, after winning 22 first, 13 championship, and 18 special prizes, and was bred in England by Mr. Edwin Brough, the donor of the head. Another male English Bloodhound bred by Mr. E. Brough is also exhibited. This animal died in 1900, and the mounted skin was purchased in 1901. A fourth specimen from the same kennel is the skeleton of the male English Bloodhound 'Burgundy' (K.C.S.B., No. 30,568), who was born on February 27th, 1891, and died November 18th, 1893, his sire being Champion 'Beckford,' and his dam 'Bianca.' In his owner's opinion he was the best Bloodhound ever bred. The skeleton was presented by Mr. Brough in 1907. A second skeleton is that of the female English Bloodhound, Champion 'Bettina' (K.C.S.B., No. 364E), who was born in April, 1899, and died in March, 1902. She was the winner of many prizes, including 8 firsts, 4 specials, and 2 championships, and was bred in England by Mr. Brough, who presented the skeleton in 1902. There is also the skull of the female Champion Bloodhound 'Brocade' (K.C.S.B., No. 49,613), presented by Mr. Brough in 1902.

Hounds. Foxhounds are represented by a statuette of 'Marquis,' a champion prize-winner in the Pytchley Pack many years ago. This statuette was modelled by Miss A. M. Chaplin, and purchased in 1906. There is also a mounted specimen of an English Foxhound, purchased in 1907. Of the Harrier, or Hare-Hound, there is a male, presented by Mr. J. S. Gibbons (the breeder) in 1906; while the head of a male Beagle presented by Mr. Rowland Ward in 1902 represents that small breed. Of the somewhat larger Basset breed the Museum possesses Champion 'Wantage' (sire Champion 'Louis le Beau,' dam, 'Witch') who was born in 1898, and died in January, 1905, after winning 9 first prizes. This specimen was presented by Mrs. A. Lubbock (the breeder) in 1905.

Pointer. The Pointer, which is merely a breed of Hound trained to hunt game in a peculiar manner, is represented by the champion female 'Sea-Breeze,' who was born in July, 1896, and died in November, 1905, her sire being 'Brodick Castle Sandy,' and her dam 'Mermaid.' She was the winner of the championship and challenge-bowl at Birmingham in 1898; of the championship and gold medal at Edinburgh in 1899; and of the championship at Birmingham in 1901. The specimen was presented by the breeder and owner, Mr. W. Arkwright, in 1905.

Griffon Hound. This is a heavily-built breed of white Hound little known in this country, and represented in the collection by a head and skull from La Vendée, France, presented by Mr. F. Adcock in 1885.

Great Danes and Mastiffs. German Boar-Hounds, or Great Danes, are represented, firstly by the champion 'Viking of Redgrave' (K.C.S.B., No. 1279F), the winner of many prizes, who was born in March, 1899, and died in March, 1902. This fine Dog, of which both skin and skeleton are shown, was bred and presented by Mrs. H. L. Horsfall. Of the Great Dane 'Duke,' the mounted head and skeleton are shown. 'Duke' was the largest Dog of his kind in England of his time, standing 35½ inches at the shoulder and weighing 12 stone 6 lbs. He died 1901, his age being unknown. He was the winner of many prizes; and his last owner was Mr. C. F. Heritage. The specimen was purchased in 1901. The female of the Great Dane is represented by a specimen purchased in 1902. On account of its early date, considerable interest attaches to the head and skeleton of the Great Dane 'Jupiter,' presented by Mr. F. Adcock in 1885. Mention may likewise be made of the skull of the female Great Dane 'Ingrath of Seisdon' (K.C.S.B., No. 1424L). Her sire was 'Vanguard of Redgrave' and her dam 'Pandora of Locherbie.' She was born in July, 1905, and died in February, 1907. The skull was presented by the Hon. W. B. Wrottesley. Of English Mastiffs the collection includes the skin and skeleton of 'Tarquinius' (K.C.S.B., No. 1489D), who was born in March, 1897, and died June, 1902. He was bred by Mr. A. Barnes, and was the winner of second prizes at Cheltenham and Epping in 1899. This Dog was presented by Mr. W. K. Taunton in 1902. To the same gentleman the Museum owes the skeleton and head of the female Brindled Mastiff 'Kathleen of Riverside' (K.C.S.B., No. 1366A). This Dog, which was bred by Mr. Taunton in October, 1894, and died in March, 1902, was the winner of the Old

English Mastiff Club's forty-guinea challenge-cup at Birmingham in 1898 and 1900, and of many other prizes. A third example represents the old English Mastiff, this specimen having been presented by Mr. H. D. Kingdon in 1888. The Cuban Mastiff is represented by a couple of skulls presented by the Zoological Society many years ago. In this place reference may be made to a mounted skin of the 'Dogue de Bordeaux,' or French Bull-dog. This breed is represented by 'Turk' (fig. 21), who was born in September, 1897, and died in 1904, his owner being the Rev. C. Steele. He was son of 'Matador du Midi,' and grandson of 'Turc,' the former of which was imported into England and took first prize at the Westminster Aquarium in 1896. These dogs were formerly used for bear-baiting. 'Turk' was purchased in 1904.

Bull-dogs. Since bull-baiting was in vogue in 1209, Bull-dogs must have existed at that time; and a document dated 1631 indicates that Bull-dogs were then recognised as distinct from Mastiffs. Old pictures show, however, that the original Bull-dog was a more Mastiff-like animal than the modern breed, and this is confirmed by the skulls in the collection. Still it always had an under-hung mouth (that is, with the lower jaw projecting in advance of the upper), an enormous gape, short, bowed front-legs, and a broad chest, such features being essential in a Dog which, unlike Wolves and Wolf-like Dogs, attacks from the front, and attempts to seize its antagonist by the muzzle. The under-hung jaws secure a hold at once, and the low body prevents goring by the horns of the bull.

Other characteristics are the short and wide skull, the small loins and hind-limbs, and the strength of the fore-quarters. These features are exaggerated in the modern breed, which is useless for fighting. The skull, for instance (as shown by the specimens in the table-case), is so broad and under-hung as to be a monstrosity, while the outward bending of the fore-legs is excessive. The old Bull-dog was a surly and pugnacious animal, whereas the modern breed is docile and gentle. The modern Bull-dog is well represented by 'Lucy Stone,' bred by Mr. W. F. Jefferies in 1900. She died in January, 1903, and, owing to her youth, was only shown three times, when she won 4 first and 5 special prizes. The skin and skeleton are both shown, and were presented by Mr. Jefferies in 1903. There is also the skeleton of a male brindled Bull-dog, presented by Mr. A. L. Sewell in 1902. The collection likewise includes the skull of the male Bull-dog 'Neotsfield,' who was born on April 23rd, 1905, and died on April 4th, 1906; his sire being 'Master Merlin,' and his dam 'Flora

Fig. 21.

FRENCH BULL-DOG, 'TURK.'

Fig. 22.

TIBET DOG.

From a drawing by Mr. Frohawk published in the *Field* newspaper.

To face p. 40.

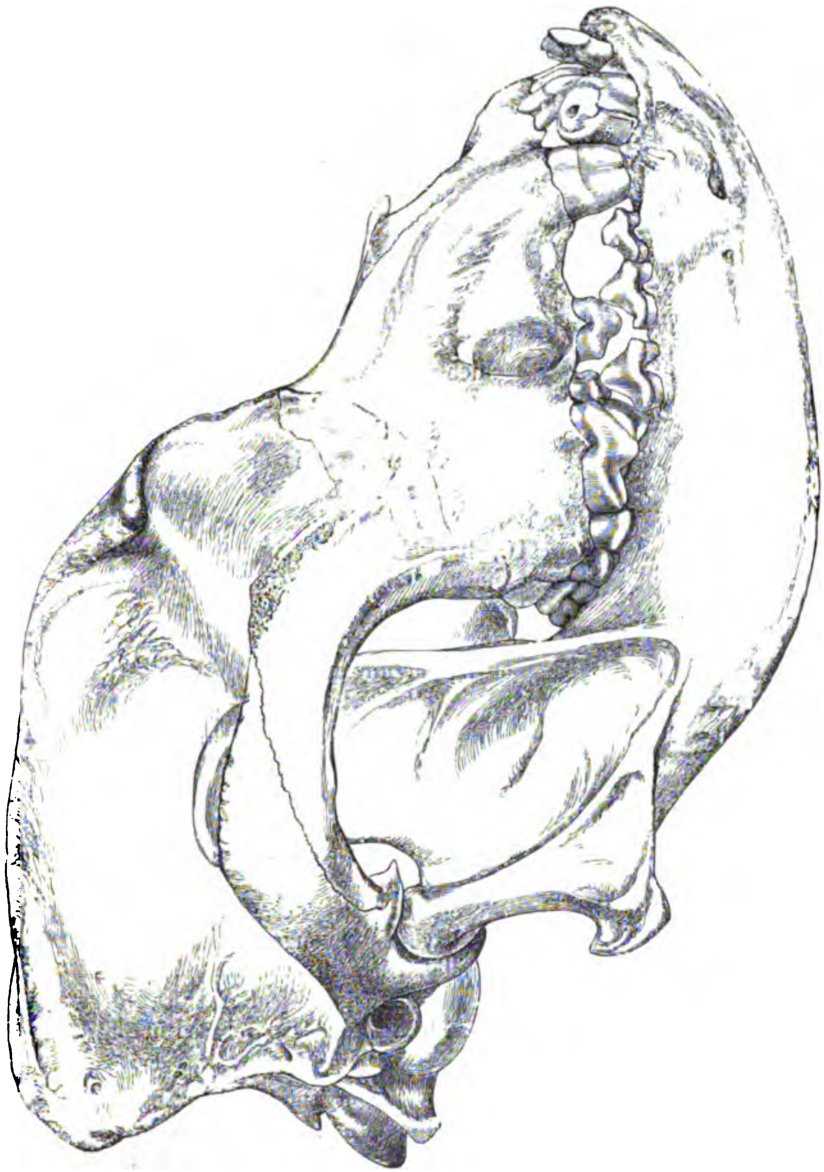


FIG. 23.—SIDE VIEW OF THE SKULL OF THE OLD ENGLISH BULL-DOG OR (?) BULL-TERRIER.
(From the Zoological Society's *Proceedings* for 1868.)

Venn.' Although only 11 months old at the time of his death 'Neotsfield' had won several prizes, and was valued at £100. The skull was presented by Mr. H. Wormsley (the breeder and owner) in 1907. Another example of the modern breed is the skull of the female Bull-dog 'Tomsh,' a first prize-winner in 1891 and 1893. This specimen was presented by Mr. J. W. Rose in 1901. As a contrast to the above, the visitor should inspect two reputed skulls of the Old English Bull-dog, which, as already mentioned, was much more like a Mastiff than is the modern breed. One of these specimens (fig. 23) was presented by Mr. E. Gerrard before 1860, while the second was also in the collection at the date mentioned. It is, however, uncertain whether these skulls may not belong to Bull-Terriers (see page 43).

Pug-dogs. The Pug, which is believed to take its name from the Latin *pugnus*, a fist (in allusion to its short and square face), is evidently related to the Mastiff and the Bull-dog, although the history of its descent is lost. It is believed, however, to have been originally produced in Holland, at a comparatively recent date. At any rate it was fashionable in that country in the time of King William III., by whom numerous specimens were brought to England, where the breed has ever since been popular. The Pug appears to have been always a fawn-coloured dog with a black face and curly tail; but about the middle of the nineteenth century two distinct strains—the Willoughby and the Morrison—were established. The former was characterised by the cold stone-fawn colour, and the excess of black, which showed itself in the completely or nearly black head and in the presence of a large 'saddle-mark' or wide 'traces.' The Morrison strain, on the other hand, had a richer and yellower fawn, with no extra blackness. The two strains are, however, now more or less completely blended. There is also a black breed, of very modern origin. Owing to the shortness of the jaws, the teeth of the Pug are crowded together, so much so that the premolar teeth frequently have their longer diameter placed transversely instead of longitudinally. A similar feature often occurs in the skulls of Pekinese and Japanese Spaniels and other Lap-dogs (fig. 20). The breed is represented by a specimen purchased in 1908.

St. Bernard and Tibet Dogs. The St. Bernard and the Tibet Dog appear to be the descendants of a very ancient breed dating from ancient Assyrian times, and represented by the 'Molossi' of classic Greece and Rome (fig. 19). In their long hair they are quite different from true Mastiffs. The St. Bernard is represented in the collection by 'The Deemster,' who

was born in July, 1897, and died in 1902. Bred by Mr. R. Allison, he was the winner of a twenty-five guinea challenge-cup, two silver shields, and other prizes. The skin and skeleton were presented by Mr. H. B. Snary in 1902. Two skulls of the St. Bernard Dog are also shown, one of them having been purchased in 1845, while the other was presented by the Hon. Walter Rothschild in 1902. The true Tibet Dog (fig. 22) is represented by a skull presented by Mr. B. H. Hodgson in 1848. There is also the skeleton of a Dog from Tibet presented by the Zoological Society in 1907, but this is not apparently a specimen of the typical breed.

Bull-Terrier. The white colour now characteristic of this breed is a modern feature, the older strains being brindled, white-and-fawn, or even black-and-tan. Bred for fighting or for rat-killing, the original Bull-Terrier appears to have been a cross between any ordinary Terrier and the Bull-dog, with, in some instances, a slight admixture of Mastiff blood. The Dogs which fought with lions in Wombwell's Menagerie at Warwick in the year 1825 were large Bull-Terriers, and not, as generally stated, Mastiffs; as were also the Dogs commonly employed in fighting in this country. The old-fashioned Bull-Terrier not only differed in colour from the modern breed but he was also a heavier and more powerful Dog. The pugnacious disposition is, however, retained by his modern white and lighter representative. The breed is represented in the collection by the head of a male, who was born in April, 1902, and died in November, 1905. This specimen was presented by Mr. Rowland Ward in 1906.

Terriers. In this group two specimens of the Black-and-Tan Toy breed, respectively known as 'Jem' and 'Gipsy,' are of interest on account of their early date. They both died in 1853, and were presented by Mr. J. Shakespeare in 1903. There is also the skeleton of a male Toy-Terrier of the same breed presented by the Countess of Cottenham in 1888.

With regard to the nature of the black-and-tan colouring met with in various breeds of Dogs, such as Terriers, King Charles Spaniels, and Setters, it has been pointed out that in all cases where this type obtains the black is restricted to the upper-parts and the outer sides of the limbs, while the tan occupies the under-parts, the inner sides of the limbs, and certain patches and spots on the face. The tan thus corresponds to the light areas, and the black to the dark ones in Dogs of other breeds. The explanation is therefore obvious, namely, that black-and-tan is the half-way stage to complete blackness or melanism.

The long-haired Skye-Terrier is represented in the collection by an unnamed specimen presented by Mr. C. L. Vandenhoff in 1907.

Of the Wire-Haired Fox-Terrier the collection includes the skin of Champion 'Donna Fortuna' (K.C.S.B., No. 869B), whose sire was Champion 'Dominie,' and her dam Champion 'Dame Fortune'; she was born on July 15th, 1896, and died June 5th, 1905, and was winner at all shows at which she was exhibited. The specimen was presented by Mr. F. Redmond, the breeder and owner, in 1905. There is also another Fox-Terrier, which died in March, 1905, and was presented by Mrs. Whitbread. The Smooth Fox-Terrier breed is represented by the skull of 'Apology,' a male, presented by Mr. Percy Morton in 1902.

Of the Aberdeen Terrier there is a mounted specimen, presented 1900; while the Griffon Dog is represented by 'La Reve des Griffons,' presented by Mr. G. F. Hobday in 1902.

The white Maltese Lap-dog is represented firstly by a specimen bred in England and purchased in 1901. Secondly, by 'Dorothy,' a female which died in 1902, and was presented by Mrs. E. Palmer in the same year. Of the Russian Lap-dog there is an immature male purchased in 1861; while the Mexican Lap-dog is represented by an immature specimen purchased at Liverpool, 1843, which was for many years exhibited in the Museum at Bloomsbury.

Poodles. The Poodle, which exhibits great variation in size, ranging from a weight of 10 lbs. to as much as 80 lbs., is a Continental breed of great antiquity. It appears, for instance, on bas-reliefs dating from about 30 A.D., at which early date its coat was partially clipped after the modern fashion; while it was painted by Bernadino Pinturicchio about 1490, and described by Conrad Gesner in 1555. Poodles display considerable variation in the character of the hair, which may be either comparatively short and curly, or 'corded,' so as to hang in long ringlets. It is stated, however, that considerable modification in this respect may be effected by the mode of dressing. Black, white, red, and silver-grey or blue strains of Poodle are recognised in this country; in addition to which there is the large brown Russian breed. Poodles, which are used in France as sporting dogs, are remarkable for their intelligence and cleverness. This breed is represented by 'Silver Lady,' who was born in February, 1901, and died in February, 1907, her sire being 'London Pride,' and her dam 'Grisette Grise.' The specimen was presented by the breeder and owner, Miss C. M.

Faithfull, in 1907. The collection also includes the skeleton of a German Poodle, presented by Mrs. Hansler in 1888.

Domesticated Cats. Domesticated breeds of Cats have probably originated from several wild species of the genus *Felis*. The striped variety of the European Domesticated Cat is, for instance, probably derived either from the Egyptian Wild Cat (*F. ocreata*), which is known to have been tamed by the ancient Egyptians, or from the European Wild Cat (*F. catus* or *sylvestris*), or from both together. Before the introduction of the Persian strain, the striped variety of European Domesticated Cat agreed very closely with the Egyptian Cat, and in Egypt many are stated to be extremely like the latter. As to the origin of the true 'tabby,' or blotched variety of Domesticated Cat (fig. 24), there is some difficulty in arriving at a satisfactory conclusion, although it has been regarded as a distinct species, to which the name *F. catus* properly belongs. In the Manx breeds, which may be either of the striped or the blotched type, the tail is reduced to a stump, or wanting. In India, where many domesticated breeds are spotted, the Egyptian Wild Cat has probably been the parent stock. A series of skins of the blotched and the striped varieties is shown.

Tortoiseshell Cats are almost invariably females, the male of this breed being sandy. The blue Carthusian Cat is a long-haired breed of a uniform greyish blue colour, with the exception of the lips and soles, which are black. The Persian or Angora breed has also long silky hair and a bushy tail; it is of large size, and the colour is frequently uniform, varying from white to yellowish or greyish, with the lips and soles flesh-coloured, and in some instances one eye yellow and the other blue. There are, however, striped, and also blotched Persians, which suggest that the breed has the same origin as the short-haired Domesticated Cats of Europe. It is, however, possible that the Bokharan Steppe-Cat (*F. caudata*), an ally of the Egyptian Wild Cat, may have had something to do with the origin of the Persian and Indian breeds. The Abyssinian Domesticated Cat seems to be a rufous phase derived from the Egyptian Wild Cat. Malay Cats have the tail short and kinked; while the Mombas Cat of E. Africa is distinguished by its stiff, wiry hair. In the Paraguay Cat the size is small, the form weasel-like, and the hair close, short, and scant, these features being suggestive of affinity with the wild *F. eyra* of South America.

The Siamese breed is short-haired, with the body fawn-coloured,

and the head, limbs, and tail dark brown; the eyes are blue, and there are two bald spots on the forehead. New-born kittens are white. It is probably also a derivative from the Egyptian Wild Cat, with which it agrees in skull-structure.

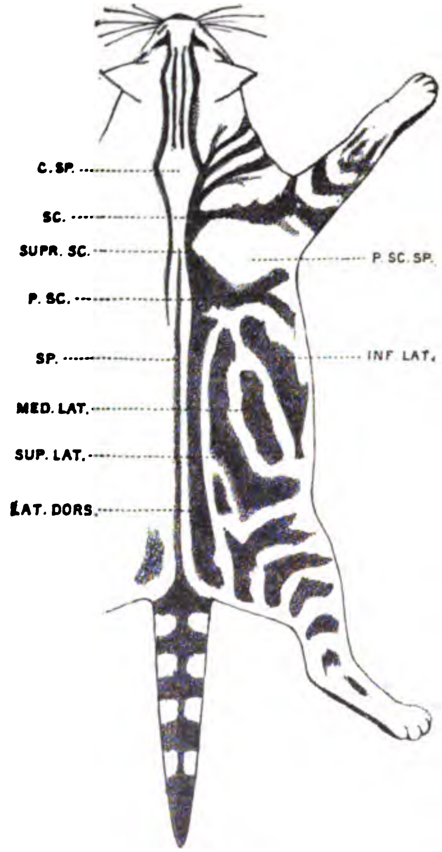


FIG. 24.—DIAGRAM OF THE COLOUR-PATTERN OF THE BLOTCHED OR TYPICAL TABBY CAT.

c. sp. cervical, or neck, space; *p. sc. sp.* postscapular space; *sc.* scapular, or shoulder, stripe; *supr. sc.* suprascapular stripe; *p. sc.* postscapular stripe; *sp.* spinal, or dorsal, stripe; *lat. dor.* lateral dorsal stripe; *sup. lat.* upper lateral, or side, stripe; *med. lat.* middle side stripe; *inf. lat.* lower side stripe. (From R. I. Pocock, in the Zoological Society's *Proceedings*, 1907.)

The most interesting specimen in the collection is the Chinchilla Persian 'Silver Lambkin,' which was the father of the Chinchilla breed, and the most noted stud-cat of its time. This Cat was born

in 1889, and died on November 5th, 1906, its sire being 'Perso,' and its dam 'Beauty.' It was bred by Miss M. Gresham (Mrs. E. T. Bridgewater), and presented by Mrs. D. B. Balding in 1907. The Smoke Persian breed is represented by the skin and skeleton of a male, bred by Miss Power in 1898, which died in 1900. The specimens were presented by Mr. W. F. Heath, The brown Tabby Persian Cat is represented by a male specimen presented by Sergeant S. Ingram in 1902; while the Blue Persian breed is shown by 'Forget-Me-Not,' a cat formerly belonging to Mrs. Herring, by whom it was presented on its death in 1903. Of the Manx Cat the collection includes a specimen from the Isle of Man, presented by Mr. G. C. Bacon in 1903; and there is also a Tailless Cat from Cornwall, presented by Mr. C. L. Hart Smith in 1903; and the skeleton of a third, presented by Mrs. Collins in 1902. The Siamese Cat is represented by an immature specimen bred in England, and presented by Mr. J. Harrington in 1902; while of the Indian Domesticated Cat there is an example purchased in 1903. Mention may also be made of the skeleton of the fore-limbs of a Many-toed, or Polydactyle Cat, having in one limb the normal first toe double and in the other triple. This interesting specimen was presented by Mr. P. E. Rumbelow in 1905.

Ferrets. The Ferret (*Putorius furo*) is a domesticated and generally albino derivative of the Wild Polecat (*Putorius fœtidus*, or *P. putorius*); and is represented by a specimen presented by Mr. W. Mayes in 1900. Brown Ferrets, or so-called Polecat-Ferrets, are generally, if not invariably, hybrids between the Ferret and the Polecat. Two examples of the Wild Polecat from Aberystwyth, N. Wales, presented by Mr. W. Ruskin Butterfield in 1902, are exhibited in the case to show the parent-form of the Ferret.

Guinea-Pigs. The Domesticated Guinea-Pig is believed to be descended from the wild Aperea (*Cavia cutleri*) of Peru, which was tamed by the ancient Incas. In the case is exhibited a specimen of the uniformly coloured phase resembling the wild race; another of the variegated phase; and a third of the rough-haired breed, originally Japanese. All three were bred in England, and presented by the Zoological Society in 1901. Two other specimens, a grey and white and an orange and white, are exhibited in order to illustrate the 'disassociation' of the two colour-elements in the original brownish grey of the wild race. In the one case we have black (mingled with white to form grey), and in the other orange.

Rabbits. All the domesticated breeds of Rabbit appear to be derived from the Wild Rabbit (*Lepus* [*Orycterolagus*] *cuniculus*) of which a normally-coloured and a black specimen are exhibited. Examples of the English Black-and-white, the Silver-grey, the Silver-brown, the Blue-imperial, the Blue-and-tan, the Dutch, the Himalayan, and the Polish breed are shown, several of which were presented by Inspector A. Brazier of the Metropolitan Police. The names Dutch, Polish, and Himalayan do not indicate the native countries of the breeds to which they are applied. Largest of all is the so-called Belgian Rabbit or Hare, at one time supposed to be a hybrid between the Rabbit and the Hare. A specimen presented by Mr. A. Crichett in 1901 is shown. The breed is related to the still larger Flemish Giant Rabbit, of which there is an example, presented by Inspector Brazier in 1901. A sandy Lop-eared Rabbit, presented by Mr. B. A. Micklewright in 1901, represents the breeds in which one or both ears are pendent. Very distinct is the long-haired Angora Rabbit, a native of the country from which it takes its name, and represented in the collection by a specimen presented by Inspector Brazier in 1901. Among other specimens of a similar nature, reference may be made to the skull of a Belgian Rabbit with the incisors abnormally long, owing to a diet of meal. This specimen was presented by Mr. W. Larcombe in 1900.

Rats and Mice. Of both Rats and Mice semi-domesticated, and in most instances partially albinistic, breeds are kept in this country. There is some uncertainty whether Domesticated Rats belong to the Brown (*Mus norvegicus*) or to the Black species (*Mus rattus*). Specimens of Pied Rats presented by the Hon. Charles Rothschild in 1901 are exhibited. Of the Mouse (*Mus musculus*) a series of domesticated varieties was presented in 1901 by Sir William Ingram. This series displays a gradation in respect of colour from the dark wild race to complete albinism. In the fawn-coloured phase the eyes are often claret-colour, and in one of the white specimens they are black, although red in the second. The pied specimens exhibit a different type of colouring.

Pigeons. In one of the cases in the Central Hall is exhibited a representative series of breeds of Domesticated Pigeons, all of which appear to be descended from the Wild Rock-Pigeon, or 'Blue Rock' (*Columba livia*), of which specimens from the Ross-shire coast are also shown. The specimens of Domesticated Pigeons, which have been presented to the Museum by a number of donors, include the following breeds: Red Pied Pouter, Blue Pigmy Pouter,

Semi-blue and Black Pied Pigmy Pouter, Blue Runt, Russian Trumpeter, Carrier, Pied Carrier, Yellow Dragon, Black Pied Scanderoon, Red-chequered Short-faced Antwerp, Short-faced Antwerp, Archangel, White Fantail, Silver Owl, Satinette, Barb, Silver Blondinette, Blue-barred Blondinette, Blue-laced Blondinette, Peaked Blondinette, Sandy Frill-back, Blue Frill-back, Starling, Suabian, Nun, Black Swallow, Magpie, Almond-Tumbler, Short-faced Almond Tumbler (skeleton), White Jacobin, Spangled Siberian Ice, Short-faced Blue-Beard, Black Short-faced Ancient, Homer or Voyageur, and Modena. There is also a pair of the Ground-Tumbler or Lotan breed from India.

Poultry. The wild Red Jungle-Fowl (*Gallus ferrugineus*), which is common in Northern India, and ranges eastward to Siam, Cochin China and the Malay countries, is supposed to be the parent stock of all the domesticated breeds of Fowls. It is represented by specimens from Sikhim, presented by Mr. A. O. Hume in 1885, which, like most of the following examples, are exhibited in a case in the Central Hall. In the same case the Wild Ceylon Jungle-Fowl (*Gallus lafayetti*) is represented by a cock and hen from Ceylon, purchased in 1905. This species is nearly allied to the Red Jungle-Fowl, but there is no definite evidence that it is the ancestor of any of the domesticated breeds; although recent experiments indicate the possibility that it may be connected with some of them. Considerable interest attaches to a group of Fowls shot in the woods on Taviuni, one of the Fiji Islands. The birds are the descendants of Domesticated Fowls left by the early voyagers more than a century ago. They have now reverted to the wild state, and assumed more or less of the characters of the Indian Jungle-Fowl. These specimens were presented by Mr. E. L. Layard in 1876. Nearly allied to the Wild Jungle-Fowl are Game-Fowls, of which an Old English Gamecock, with the comb, wings, and tail trimmed for fighting, and artificial spurs on the legs, is exhibited. This bird was trimmed more than forty years ago by an expert, and was purchased in 1905.

Coloured Dorkings are represented by a cock and hen presented by the Hon. Florence Amherst in 1904, and by a second pair presented by Messrs. John Baily and Sons in the same year. Of the Buff Cochin breed a pair is exhibited of which the cock was the winner of fifty, and the hen of more than forty prizes. They were presented by Mr. G. H. Proctor in 1900. The curious White Silky breed is represented by a cock and hen from France,

purchased in 1905. In these fowls the plumage has assumed a soft and silky character, with the loss of the stiff wing and tail feathers. A still more remarkable modification is presented by the Tail-less breeds, of which a cock and hen are exhibited. In these breeds not only the tail-feathers, but even the bones of the tail are absent. There are various breeds of Tail-less Fowls differing in size and colour. The birds exhibited are from Holland, and were presented by Mr. A. J. Bicker Caarten in 1895.

Another remarkable deviation from the normal condition is displayed in the tails of a peculiar breed of Fowls from Japan. The true tail-feathers of the cocks, but more especially the tail-coverts, are increased in number, and elongated to an extraordinary degree ; a single feather in one of the specimens exhibited measuring upwards of nine feet in length. According, however, to descriptions and figures published in Japan, tails of nearly twice this length are known. The great difficulty in keeping these birds arises from the precautions necessary to prevent their tails being injured. They are accordingly confined in high narrow cages, without room to turn, and only allowed exercise for a short time daily on a perfectly clean floor. The hens of the same breed are but slightly modified in the same direction. Two of the specimens exhibited were presented by the Tokio Museum in 1887, and the third by Mr. F. D. Parker in 1888.

Ducks and Geese.

Domesticated Ducks are probably all derived from the Wild Duck or Mallard (*Anas boscas*), of which specimens are exhibited in one of the cases in the Central Hall. One of the most remarkable domesticated breeds is represented by the so-called Penguin-Ducks, which are natives of Java and some of the neighbouring islands. They differ so remarkably from all other breeds that it has been suggested that their origin is also different ; but Darwin was of opinion that, like other breeds, they trace their descent to the Wild Duck, their special peculiarities being in some degree the result of an unnatural climate. Penguin-Ducks take their name from the nearly erect carriage of the neck and body, which are unusually thin. The wings are short, the tail is turned up, and the bones of the leg are relatively longer than in the Wild Duck. Usually, at any rate, there are only 18 tail-feathers, in place of the 20 of the Wild Duck ; and there are also fewer scales on the toes than in the latter. There is considerable variation in the colour of the plumage ; and the presence of a crest on the head is not a constant feature of the breed. The specimens exhibited came from Buitenzorg, Java, and were presented by Dr. M. Treub in 1906. The only other breed at present represented in the

collection is the Cayuga, or American Large Black Duck, of North America, of which a specimen presented by Major H. Fothergill in 1901 is shown. The only specimen of Geese at present exhibited is of the Chinese Domesticated Goose, presented by Mr. H. Greenway.

Canaries. The origin of most domesticated animals is more or less completely lost in antiquity, and few additions have been made to the list since the commencement of the Historic Period. One of the most recent is the Canary Bird (*Serinus canarius*), first imported in the early part of the sixteenth century into Europe, when it soon became completely domesticated and has in consequence undergone great modifications. It was originally a native of the Canary Islands, Madeira, and the Azores. The tame birds exhibited are typical examples (being nearly all prize-winners at shows) of the best marked breeds at present cultivated in this country. Many were presented through the good offices of Mr. W. H. Betts, Honorary Secretary of the Cage-Bird Club. The series includes a pair of Wild Canaries and their nest, from Madeira; while the following breeds are also represented. The Norwich, by a bird which was the winner of eighteen prizes between 1890 and 1893, and was presented by Mr. E. J. Philpot in 1894. The Yellow Cinnamon Norwich, by a specimen which took the first prize at the London Cage-Bird Association Show in 1894, and was presented by the Rev. W. K. Suart in 1894. The Yellow Norwich, by a specimen presented by Messrs. Mackley Brothers in 1897, the donors of the next three specimens. The clear Yellow Norwich Plainhead, by a first prize winner. The evenly marked Buff Norwich. The unevenly marked Buff Norwich Plainhead, by a first prize winner. The dark-crested variegated Buff Norwich, by a specimen presented by Mr. George Crabb in 1894. The Crested-bred Norwich, by a great prize-winner, presented by Dr. W. J. Greene in 1897. The Yorkshire Variegated Buff, by an example presented by Mr. E. P. S. Elfick in 1894. The Yorkshire, by an example of the prize-breed, presented by Mrs. Lowe in 1904. The Lancashire Yellow Coppy, by a specimen presented by Mr. F. J. Green in 1894. The Lancashire Plainhead Buff, by a bird which took the first prize at Rochdale in 1883, and was presented by Mr. G. R. Kennerley in 1894. The golden-spangled clear-cap Lizard, by a cayenne-fed bird, presented by Mr. J. Naden in 1895. The clear Buff Crested, by an example presented by Dr. W. T. Greene in 1894, and by a bird which took the first prize at the Royal Aquarium in 1894, and was presented by Mr. F. S. Weinberg in the same year.

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Frontispiece.

THE AFRICAN ELEPHANT (*Elephas africanus*)
in the Central Hall.
Height 11 feet 4 inches.

3.

GUIDE

TO THE

GREAT GAME ANIMALS
(UNGULATA)

IN

THE DEPARTMENT OF ZOOLOGY,

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

ILLUSTRATED BY 53 TEXT AND OTHER FIGURES.

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1907.

and the greater portion of the East and South Corridors. Reference is, however, also made to many of the domesticated representatives of the order Ungulata exhibited on the ground-floor in the North Hall.

In many of the groups of Mammals the exhibited series is limited to the display of specimens of only a comparatively small percentage of the known species. On account of the exceptional interest of the present group a very much larger proportion of the species is, however, shown to the public, and it may be hoped that it will eventually be found possible to exhibit all the larger species of which specimens are procurable.

E. RAY LANKESTER,
Director.

BRITISH MUSEUM (NATURAL HISTORY).
October, 1906.

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GUIDE

TO

GREAT GAME ANIMALS.

WITH the exception of the large Carnivora, such as lions, tigers, leopards, bears, and wolves, all the animals coming under the designation of "Great Game" are included in the group or "order" of Hoofed Mammals, or UNGULATA. Of these animals the collection exhibited in the galleries of the Museum is remarkably fine and, in fact, unique. Although most of the members of the group are of considerable or large dimensions, a certain number are comparatively small. It will, however, be obvious that the entire group must come within the scope of the present guide.

As a whole, the Ungulata or Hoofed Mammals are specially adapted for a life on the ground and, in the main, to subsist on vegetable food, although a few are mixed feeders. In accordance with the needs of such a diet, their molar, or cheek, teeth have broad crowns, the summits of which carry tubercles or ridges well suited for crushing and grinding vegetable substances. Their feet are protected in some cases with blunt, broad nails, but in the greater number of species with hoofs, which more or less completely enclose the terminal joints of the toes on which they mainly or entirely walk.

The large bodily size of so many of the members of this order renders it very difficult to arrange them all in their proper

sequence in a Museum. It has been necessary not only to make them occupy most of the central line of the Lower Mammal Gallery, but also to overflow into the West and East Corridors; while the Elephants have been removed to the Central Hall and the Geological Department, so as to be in association with their extinct relatives.

The great majority of existing Ungulates are included in the two subgroups, or suborders, Perissodactyla and Artiodactyla, of which the latter is much more numerously represented than the former. A large number of the members of the order—more especially the Artiodactyla—are furnished with horns. These present several structural types, representatives of which are exhibited in the West Corridor behind the Kudu case.

I. The simplest type is that of the Giraffe, in which three bony prominences—a single one in front and a pair behind—quite separate from the underlying bones and covered during life with skin, occupy the front surface of the skull. The summits of the hind pair are surmounted by bristly hairs. In the extinct *Sivatherium* (of which a skull is shown in the East Corridor) there are two pairs of such appendages, the hinder being large and probably covered during life either with skin or thin horn. In the male Okapi there are small bony caps, comparable to antlers, to the simple skin-covered horns.

II. In the Asiatic Muntjac Deer we find a pair of skin-covered horns, or "pedicles," corresponding to the paired horns of the Giraffe, although welded to the skull. From the summits of these pedicles arise secondary outgrowths, at first covered with skin, which (owing to the growth of a ring of bone at the base arresting the flow of blood) eventually dries up and leaves bare bone incapable of further growth. In the Muntjac the bare bony part, or "antler," is small in proportion to the skin-covered pedicle, and simple in structure; but in the majority of Deer, as in the Roebuck (of which antlers in the skin, or "velvet," and also in the clean condition are shown), the antler increases in size at the expense of the pedicle—which dwindles—and in some species, like the Sambar and Red Deer, becomes very large and more or less branched. Owing to liability to necrosis, the permanent retention of such a mass of dead bone would be dangerous; and the antlers

are consequently shed annually (or every few years) to be renewed the following year, when, till the animal becomes past its prime, they are larger than their predecessors. The periodical shedding is also necessary in order to allow of this increase in size. With the exception of the Reindeer, antlers are confined to the males.

III. A third type of horn is presented by the American Prongbuck, or Pronghorn, in which bony processes, or "cores," corresponding to the horns of the Giraffe, have acquired a horny sheath, in place of skin; the sheath being in this instance forked, and annually shed and renewed, although the core is simple. The sheaths are akin to hair in structure, thus suggesting affinity with the hairs surmounting the Giraffe's horns. Female Prongbuck may or may not have horns.

IV. In the great majority of "Hollow-horned Ruminants," such as Oxen, Sheep, Goats, and Antelopes, the horny sheath (or true "horn") forms a simple unbranched cone, which may be compressed, spirally twisted, or curved in one or more directions, but is permanently retained and continues to grow throughout life from the base, while it becomes worn away at the tip. Some of the leading modifications of this type of horn are shown in the West Corridor and described in special labels. Rarely, as in the Four-horned Antelope, there are two pairs of horns. In many cases these horns are present in both sexes.

V. The last type is that of the Rhinoceros, in which the one or two unpaired horns consist throughout of "horny" matter (that is to say, hair-like fibres closely welded together), with merely a slight hollow at the base which fits upon a corresponding elevation on the skull. Apparently this type of horn has had an entirely independent origin, starting as a small horny nodule and gradually increasing in size. The idea that it can have been derived from a horn of the Ruminant type by the gradual dwindling of the core and the solidification of the sheath seems to be negatived by the fact that the early Rhinoceroses were hornless. These horns are present in both sexes.

Suborder PERISSODACTYLA.

[Lower Mammal Gallery. Cases 37 to 40, and two cases in the central line.]

In this group the middle, or third, toe of both fore and hind feet (fig. 2) is larger than any of the others and symmetrical in itself, its centre constituting the middle line or axis of the whole foot. This may be the only toe present, as in Horses (fig. 1), or the second and fourth may be subequally developed on each side of it. In the Tapirs the fifth toe is also present in the fore-foot, but no existing species shows any trace of a first toe. This group at the

Fig. 1.

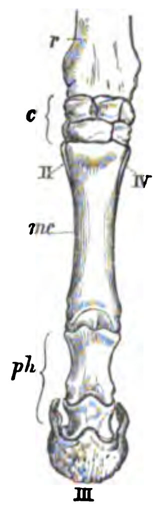
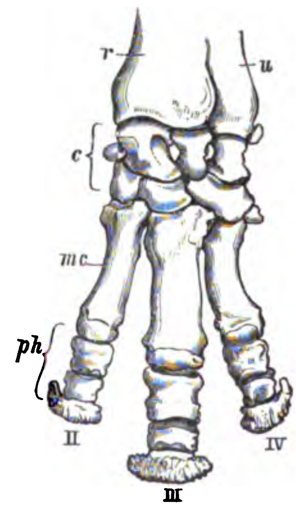


Fig. 2.



Bones of the Left Fore-foot of a Horse (1) and a Rhinoceros (2).
r, radius; *u*, ulna; *c*, carpus; *mc*, metacarpus; *ph*, phalanges.

present time consists of only three distinct families, the Tapirs, Rhinoceroses, and Horses (including Asses and Zebras); all these being poor in genera and species, and evidently, as shown by the evidence of fossil remains, merely the surviving remnants of a very extensive and varied assemblage of animals which flourished on the earth during almost the whole of the Tertiary geological period. The two domesticated species, the Horse and the Ass, have been largely multiplied and widely dispersed over the surface of the

earth by human agency, but the others have mostly a very restricted geographical range.

The Tapirs.
Family Tapiridæ.

The Tapirs form a family of Perissodactyla remarkable at the present day for their anomalous geographical distribution, one species (*Tapirus indicus*, **991**) inhabiting the Malay countries, whereas the other four are confined to Central and South America. The clue to this peculiarity is afforded by extinct species, remains of which occur in the Tertiary rocks of Europe, China, and North America. From other living members of the suborder, Tapirs are distinguished by having four front-toes; the hind-feet, as in the Rhinoceroses, terminating in three digits. The nose is prolonged into a short proboscis, and the molar teeth of both jaws are low-crowned, and carry simple transverse crests, united in the upper ones by an outer wall. The number of teeth is 42, or only two below the full typical complement. The heavy form of the body, the small size of the eyes, and the shortness of the tail, are shown in the specimens exhibited. In the typical members of the genus, like the Malay *T. indicus* (**991**) and the American *T. terrestris* (**992**), the nasal region of the skull is of normal structure; but in two of the American species (*Tapirus bairdi*, **993**, and *T. dowi*) a bony partition divides the cavity of the nose into two divisions. These two species are in consequence separated generically, or subgenerically, as *Tapirula*. The young of all are spotted and striped. [Lower Mammal Gallery. Case 36.]

Tapirs are dwellers in dense forest, where water is abundant. In this they swim, and even dive, while they also enjoy wallowing in mud, and in the deep forest wander about during the day, generally alone. Although usually slow in their movements, when frightened they make violent rushes. Their food consists of leaves, twigs, and fruits.

Rhinoceroses.
Family Rhinocerotidæ.

Rhinoceroses are the largest and bulkiest of the existing Perissodactyla; and although now confined to Africa and the Indo-Malay countries, in past epochs ranged over the greater part of Europe and North America. Their most distinctive feature is the presence [Lower Mammal Gallery. Cases 37* & 40, H & J.]

of one or two horns in the middle line of the fore-part of the head; this, together with the presence of only three front toes, in the living forms, distinguishing them from the Tapirs. The upper molar teeth are of a more complex type than those of the latter; and the lower molars have curved, instead of straight, cross-crests. The horns, as stated above, are attached only to the skin, and have no connection with the bones of the skull. Rhinoceroses have very thick skins—which may be thrown into folds and carry but a scanty covering of hair—small eyes, and moderate-sized, tubular ears. They show but little intelligence, and although usually timid in disposition, display great ferocity when brought to bay. Whereas, however, the African species attack with their horns, those from Asia make use of their lower tusks. Although the sight is dull, their senses of smell and hearing are acute. Some kinds browse on the boughs of trees, and others graze on grass; but all are fond of water and of wallowing in the mud.

Asiatic Rhinoceroses. Three species of Rhinoceros are recognised from Asia, in all of which the skin is thrown into definite folds or flaps; while cutting-teeth are present in the front [Case H.] of the jaws, and the nasal bones of the skull are pointed. By far the largest of the three is the Great Indian Rhinoceros (*Rhinoceros unicornis*, **999**, fig. 3 *c*), in which the folds of the skin are very strongly marked, and there are large tubercles on the hind-quarters. Only a single horn is present; and the fold across the shoulders is not continued over the back. The upper teeth are of a complex type, with a flat plane of wear. This Rhinoceros inhabits the tall grass-jungles of Assam, in which it forms "runs," or tunnels, completely concealed from view. The specimen exhibited was presented by H.H. The Maharaja of Cooch-Behar. The species is confined to India. The smaller Javan Rhinoceros *R. sondaicus*, **1000**) differs by the fold in front of the shoulder being continued across the neck, and by the small polygonal plates on the skin. The molar teeth are of a simpler type than in the last, and wear into ridges. This species, of which a young [Case J.] specimen and a skull are exhibited, ranges from the Sandarbans of Bengal to Java. In the Sumatran Rhinoceros (*R.* [*Dicerorhinus*] *sumatrensis*, **1001**) the molars are of the same type as in

FIG. 3.—Heads of Burchell's or White Rhinoceros (*Rhinoceros simus*) (*a*), Common or Black Rhinoceros (*R. bicornis*) (*b*), and Great Indian Rhinoceros (*R. unicornis*) (*c*).

the last, but there are two horns, and the skin is smoother, with no fold crossing in front of the shoulder. Although variable in this respect, this species is the most hairy of all the Rhinoceroses, as it is the smallest. Its range extends from the Bengal Sandarbans to Sumatra, and there are several local races; the two specimens exhibited belonging to the dark-coloured Malay race.

African Rhinoceroses.

Africa is the home of two species of Rhinoceros, in both of which there are no distinct folds in the skin; teeth are absent from the front of the jaws of the adult, there are two large horns placed close together, and the nasal bones of the skull are blunt and rounded. Of the two species, the larger is the White Rhinoceros, also known as Burchell's or the Square-mouthed Rhinoceros (*Rhinoceros* [*Diceros*] *simus*, **1002**, fig. 3 *a*), formerly numerous in the districts to the north of the Orange River, but now nearly exterminated, although existing in
[Case 37.] Central Equatorial Africa near Lado. The most distinctive external features of this species are the short and truncated muzzle, and non-prehensile upper lip; but it is also well characterised by the very complex pattern of the grinding-surface of the upper molar teeth, which become worn quite flat. Its food consists solely of grass.
[Case H.] In the Common, or Black, Rhinoceros (*R.* [*Diceros*] *bicornis*, **1003**, fig. 3 *b*) the upper lip is distinctly prehensile, and the upper molar teeth are of a simpler type, their grinding-surfaces being ridged. This species feeds entirely on leaves and twigs. There is great variation in respect to the relative lengths of the two horns; those individuals in which the second is as long as or longer than the first have received the name of Keitloa.

[Lower Mammal Gallery. Cases 38, 39 & 39*.]

Horses.

Family Equidæ.

This family, which includes true Horses, Zebras, and Asses, is now represented only by the genus *Equus*, although in past times there were several other types. From the other two existing families of Perissodactyla, modern *Equidæ* are distinguished by the tall crowns and complex structure of their cheek-teeth, in which all the hollows and valleys formed by the infoldings of enamel are filled by cement, so as to form a grinding surface of a perfect type. Another feature is the presence of an infolding of the enamel in the summits of the incisors, thus producing what is called the

"mark." In the skull the enclosure of the socket of the eye by a complete bony ring is also unknown in the other members of the suborder. In all existing Horses there is only one toe on each foot, although rudiments of lateral digits are represented by the "splint-bones" on each side of the upper end of the cannon-bones. In the extinct three-toed Horses (*Hipparion*) there were three complete digits to each foot, although the lateral pair was small. In the earlier *Anchitherium* the lateral toes were relatively larger, and the molar teeth had short crowns, with the valleys free from cement. From this animal there is a transition to the small four-toed *Hyracotherium*, which was not larger than a fox, and formed one of the earliest ancestors of the family. A series of specimens illustrating the ancestry of the Horse, and another displaying the alterations in the teeth with age are shown in the North Hall. Horses, Zebras and Asses are inhabitants of open plains, where they wander in droves headed by an old stallion.

The Horse. The Horse (*Equus caballus*) is markedly distinguished from the other species of the genus by having the tail completely clothed with long hairs, and by the long flowing mane. It has bare callosities on both pairs of limbs, instead of on the front pair alone; and the head is relatively smaller, the ears are shorter, the limbs longer, and the hoofs broader.

Two distinct types of Horse, in many instances largely modified by inter-breeding, appear to exist.

1st.—The Northern, or Dun type, represented by the Dun Ponies of Norway (*Equus caballus typicus*), the closely allied Celtic Pony (*E. c. celticus*), of Iceland, the Hebrides, etc., and the Wild Pony of Mongolia (*E. c. prezewalskii*), to which the now extinct Tarpan of the Russian steppes appears to have come very close. The prevalent colour is yellow-dun, with dark brown or black mane, tail, and legs; in the wild breed the muzzle is often white and the root of the tail short-haired; while the head is relatively large and heavy. No depression exists in the skull in front of the eye. Most of the ordinary Horses of N.W. Europe are descended from the dun type, with more or less admixture of Barb blood.

2nd.—The Southern, or Barb type, represented by Barbs, Arabs, Thoroughbreds, etc. (*E. c. asiaticus*, or *libycus*), in which the

typical colour is bay with black "points" and often a white star on the forehead, and the mane and tail are long and full. The skull generally shows a slight depression in front of the socket of the eye. Many of the dark-coloured Horses of Europe have Barb or Arab blood in their veins, this being markedly the case with the Old English Black, or Shire Horse, the skull of which shows a distinct depression in front of the eye-socket. This depression is still more marked in the extinct Indian *E. sivalensis*, which may have been the ancestral form.

[North Hall.]

In this connection, attention may be directed to the series of skulls of famous Thoroughbred and Shire Horses exhibited in the North Hall. The skulls of Race-Horses include those of "Stockwell," "Bend-Or," "Ormonde," and "Donovan"; while Shires are represented by "Blaisdon Conqueror" and "Prince William," both famous horses in their time. The presence in the skull of Thoroughbreds and Arabs of the above-mentioned slight depression in front of the socket of each eye is noteworthy, since this, although now serving as the attachment for the muscle running to the nostril, may represent a much deeper depression in the skull of the extinct three-toed *Hipparion* (shown in a Table-case in the North Hall), which has been regarded as the receptacle for a face-gland like that of Deer and many Antelopes. The limb-bones of "Stockwell" and "Blaisdon Conqueror" are exhibited in a wall-case in order to show the difference between the Thoroughbred and the Cart-Horse types.

[Lower Mammal Gallery. Case 39*.]

Asiatic Wild Asses. Asses resemble the Horse in the absence of stripes, although there may be a dark streak down the back, and at times another across the shoulders, and bands on the limbs. The Asiatic Asses, which might well be collectively called Kiangs or Onagers, have moderate ears, the tail rather long, and the back-stripe dark brown and running from head to tail. On the neck and withers this stripe is formed by the mane. They come nearer to the Horse than do any other members of the family. There are two species of Asiatic Wild Ass, with several varieties. The first and largest has two races—the Chigetai (*Equus hemionus*) of Mongolia, and the Kiang (*E. h. kiang*, **1013**) of Tibet, which is a redder animal. The Onager (*E. onager*), of which there are several races, is smaller, with a

broader dorsal stripe, bordered with white; the colour varying from sandy to greyish. This species ranges from Baluchistan and N.W. India to Persia, Syria and Arabia.

These Asses inhabit desert plains, or open tableland; the Kiang dwelling at elevations of about 14,000 feet. They are generally found in herds of from twenty to forty, although occasionally in larger numbers. All are fleet, and traverse rough ground with speed. On the lowlands they feed on dry grasses, and in Tibet on small woody plants. In India and Persia they are difficult to approach, although this is not the case in Tibet.

The Zebras and Quaggas. Zebras and Quaggas, which are confined to Africa south of the Sahara, are recognisable by being more or less fully striped. The largest is Grévy's Zebra (*Equus grevyi*, **1025**, fig. 4), distinguished by its large and broad ears, which are very hairy inside, the narrow and more numerous stripes, with a peculiar arrangement of their own, the tall mane, extending on to the withers, and the thickly-haired tail. A second subgroup is represented by the Quagga (*Equus quagga*, **1017**), now extinct, and Burchell's Zebra (*Equus burchelli*), locally known as the Bonte-Quagga (**1018**). They have small narrow ears, broader stripes, which extend across the lower surface of the body, and smaller manes. In the Quagga, a South African species, the stripes are confined to the head and fore-part of the body. In the typical race of Burchell's Zebra, now nearly extinct, but formerly abounding on the plains north of the Orange River, the lower part of the hind-quarters and both legs were devoid of stripes. Further north there are numerous races of this species, such as *E. burchelli crawshayi* (**1019**) in which the legs are more or less fully striped, while in *E. burchelli granti* (**1020**), of N.E. Africa, the striping extends to the hoofs. In that race the stripes are alternately black and white, instead of brown or buff, without the intervening "shadow-stripes," of the southern races. Lastly, there is the True or Mountain Zebra (*Equus zebra*, **1024**) of the Mountains of Cape Colony, represented in Angola by *E. z. penricei*. In this animal the ears are longer and the whole build is much more like that of the African Wild Asses, although the direction of the hair along the spine is reversed. The stripes do not extend across the under surface of the body; a distinctive

[Lower Mammal Gallery. Cases 38 & 39.]

feature being the presence of transverse bars connecting the back-stripe with the oblique stripes on the hind-quarters. A Zebra from N.E. Rhodesia has been named *E. annectans*. The exhibited specimen of the Quagga is the one presented in 1858 by

FIG. 4.

Head of Grévy's Zebra (*Equus grevyi*).

Sir George Grey to the London Zoological Gardens, where it lived for many years.

[Lower Mammal Gallery. Case 39*.]

African Wild Asses.

The last group of the *Equidæ* is represented by the Wild Asses of North Africa and their domesticated descendants, all of which are included under the designation of *Equus asinus* (**1014** & **1015**). The very long and pointed ears, the prevailing bluish grey colour, with a stripe on the back and shoulders, or bars on the legs (or both combined), the small hoofs, and the smooth, terminally-tufted tail are the distinctive features of this species, of which there are two wild races. The

larger of these is the Somali Wild Ass (*E. asinus somaliensis*, **1015**), distinguished by the absence of stripes on the back and shoulders and the presence of dark barrings on the legs; it is represented by a specimen shot by Lt.-Col. A. Paget. Side by side with this is an example of the smaller Nubian race (*E. a. africanus*, **1014**), from the Atbara River, presented in 1904 by the Hon. Charles Rothschild, which shows the narrow stripe along the middle of the back, and the broader but very short one across the shoulders characteristic of the race, in which the legs are uniformly coloured.

SUBORDER ARTIODACTYLA.

[Lower Mammal Gallery. Cases 41 to 66; most of the cases in the central line of the gallery, and all those in the Corridors.]

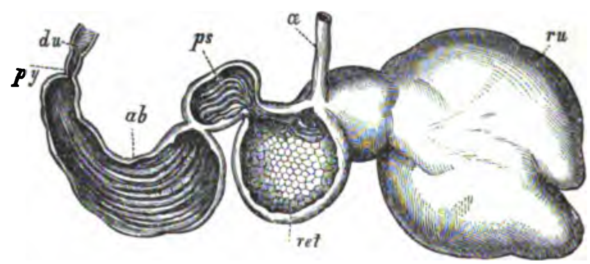
The members of this suborder are distinguished from the Perissodactyla by numerous anatomical peculiarities, among which the structure of the limbs is the most striking externally. The third and fourth toes of all the feet are almost equally developed and flattened on their inner or contiguous surfaces, so that each is not symmetrical in itself, but when the two are placed together they form a figure symmetrically disposed to a line drawn between them (the so-called "cloven hoof"). Or, in other words, the axis, or median line of the whole foot is a line drawn between the third and fourth toes. These may be the only toes present, or there may be also the second and fifth, but always of much smaller size. A large number of species have a pair of horns or antlers growing from the frontal bones. This group includes the Hollow-horned Ruminants (Oxen, Sheep, Goats, and Antelopes), Giraffes, Deer, Chevrotains, Camels, and Pigs. They (especially the first-named) are now the dominating members of the great Ungulate order, widespread in geographical range, rich in generic and specific variation, and numerous in individuals.

Hollow-horned Ruminants.
Section PECORA.
Family Bovidæ.

The *Bovidæ*, *Antilocapridæ*, *Giraffidæ*, and *Cervidæ* collectively constitute the section PECORA, or True Ruminants. In all this extensive group of Artiodactyle Ungulates there are no upper incisor teeth, and the lower canines, or tusks, are approximated to the incisors to make a uniform series. The molar teeth, which are frequently very tall, have the columns

forming their crowns completely crescentic; and the premolars are of the same general structure as the molars, although simpler. In both limbs the third and fourth metapodial (metacarpal and metatarsal) bones are united to form a cannon-bone, which terminates below in a pair of pulley-like surfaces for the bones of the toes. Internally these Ruminants are characterised by the complex structure of the stomach, which is divided into four distinct compartments (as shown in fig. 5), each differing in size, conformation, and function from the other.

FIG. 5.



The Stomach of a Sheep, cut open to show the internal structure.

æ, œsophagus, or gullet; *ru*, rumen, or paunch; *ret*, reticulum, or honeycomb; *ps*, psalterium, or manyplies; *ab*, abomasum; *py*, pylorus; *du*, duodenum, the commencement of the small intestine.

As a family, the *Bovidæ* (which include Oxen, Sheep, Goats, and Antelopes) are chiefly characterised by the possession—at least in the males—of hollow, unbranched horns, which, at all events after very early life, are never shed, and are supported on bony cores of nearly similar form. In none of them are upper canine teeth normally present; and the lower canines (fig. 38 B, p 50) have narrow simple crowns, similar to those of the incisors with which they form a continuous series. When lateral hoofs are retained, these are never supported by more than mere nodules of bone.

Wild Oxen. Genus Bos. Under the title of Oxen may be included not only the domesticated animals properly so called, but likewise Bison, Yak, and Buffaloes. They are nearly all [Cases 41–44.] large, heavily built Ruminants, with short necks, and massive heads; both sexes being furnished with long horns, and the males generally having a dewlap on the throat and chest. The horns are

situated high up on the head, and may be either rounded or triangular, but never have the transverse ridges of those of the Sheep or the knobs of the Goats. The broad muzzle is moist and naked, and there are no glands below the eye. The upper molar teeth differ from those of Sheep and Goats by their nearly square section, and have an additional column on the inner side.

Some members of the group inhabit open grassy plains, but others frequent forests, and the Yak is found in the highlands of Tibet. Except the Anoa, they live in herds, which may comprise thousands of individuals, and are headed by bulls. Some very old bulls may, however, become solitary. Their food consists either of leaves, twigs, and grasses, or various marsh-plants. Usually only one calf is produced at a birth.

Typical Oxen.
Bos taurus.

The Aurochs, or Urus—the old Wild Ox of Europe—is now completely extinct as a wild species, although most European domestic breeds may be regarded as its more or less modified descendants. The remains of this Ox (*Bos taurus primigenius*) occur abundantly in the fens and river-gravels of Britain, and—as exemplified by the skull and limb-bones exhibited—indicate an animal of enormous size and strength. [North Hall.] In Britain this original race appears to have become extinct by the time of Cæsar—at least in the southern parts of the country; but on the Continent it survived to a very much later date. In England it was succeeded by the so-called Celtic Shorthorn (*Bos taurus longifrons*), which appears to have been a domesticated breed. The half-wild white cattle of Chillingham and some other British Parks have been regarded as the direct wild descendants of the Aurochs, but they are really domesticated albino breeds nearly related to the black Pembroke cattle (of which a head is exhibited). The Pembroke breed appears to be very closely allied to the Aurochs, which is known to have been black, with a lighter stripe down the back. A mounted specimen of a bull of the white cattle of Chillingham Park, Northumberland, presented by the Earl of Tankerville, is exhibited; while the head of a cow and the skeleton of a bull are likewise shown. Of the white cattle formerly kept at Chartley Park, Staffordshire,—most of the remnant of which was transferred in 1905 to Woburn Abbey—the mounted head and the skull of a cow, presented by the Duke of Bedford,

are exhibited in the North Hall. All the white Park Cattle have black or red ears, which is itself an indication of their derivation from a dark-coloured breed; and it is noteworthy that there is a white breed of Pembroke Cattle with black feet, muzzles, and ears, which is practically identical with the Chillingham Park cattle.

The black Spanish Fighting Bulls, of which a specimen (presented by Mr. E. F. Johnston in 1902) is exhibited, are probably also nearly related to the Aurochs, and show a similar pale-coloured stripe down the back. It has likewise been suggested that the fawn and white Siemental Cattle of Switzerland, a miniature model of a bull of which is shown, are near akin to the ancient Wild Ox.

The Ankole Cattle of Uganda, characterised by the enormous size of the horns, as shown in a mounted head and a skull presented by Lt.-Col. Delmé Radcliffe, appear to be allied to the ancient Egyptian breed, of which skulls (from tombs) are also exhibited. To this breed the name *Bos ægyptiacus* has been given, as it appears to be markedly distinct from the Aurochs group.

Humped Oxen.
Bos indicus.

The ordinary Cattle of India, as well as those from many parts of Africa, Madagascar, and China, differ from European breeds by the presence of a fleshy hump on the shoulders, the convexity (in place of concavity) of the first curve of the horns, and the presence of a white ring round the eyes and another round each fetlock. The colouring, too, is of a different type, while the voice and habits are also distinct from those of European Cattle. Humped Cattle, or Zebu, belong indeed to a separate species (*Bos indicus*), the wild ancestor of which is extinct and unknown. A Brahmini or Zebu bull is exhibited in the North Hall, where horns of the Galla breed of Humped Cattle, characterised by the immense size of these appendages, are also shown. Not improbably the fawn-coloured Spanish Draught Cattle—of which two heads belonging to animals formerly kept at Osborne, and presented by His Majesty the King in 1902, are exhibited—have a strain of Zebu blood. The evidence for this is afforded by the form and curvature of the horns, and the presence of indistinct white rings round the eyes. Tradition also points to the existence of such a cross.

[North Hall.]

Indo-Malay Wild Oxen. Subgenus Bibos. The Gaur, *Bos* [*Bibos*] *gaurus* **1031**, the Gayal, *B.* [*B.*] *frontalis* **1030**, and the Banting, or Bantin, *B.* [*B.*] *sondaicus* **1027**, form a group of Cattle confined to the Indo-Malay countries, showing the following distinctive features. The horns are more or less flattened, especially in the bulls; the tail is shorter than in the typical Oxen, reaching at most only a little below the hocks; and there is a distinct ridge running from the shoulders to the middle of the back, where it ends in a sharp drop. In the adult males the colour of the short hair is usually dark brown or blackish; but in the young of both sexes, as well as in the female Banting at all ages, it is reddish brown; while in the Burmese race of the Banting, known locally as the Tsaine (**1028**), the colour of both sexes is pale fawn. From the knees and hocks to the hoofs the legs are white, or whitish. The Gaur is distinguished by the great curved crest between the horns; the same part in the Gayal being straight. The Banting is the smallest of the three; and has rounder horns, the ridge on the back less developed than in the other two, and a white patch on the buttocks. [Lower Mammal Gallery. Case 42.]

Gaur, commonly called Indian Bison by sportsmen, are met with in hill-forest from India and Burma to the Malay Peninsula, where they are known as Saladang. A male and female are exhibited. The Gayal is probably nothing more than a domesticated breed of the Gaur; and is kept for its milk by the natives of the hill-districts of North-Eastern India and Tenasserim. A bull is exhibited in the Lower Mammal Gallery and the head of a cow in the North Hall. The Banting ranges from Burma and the Malay Peninsula to Java and Borneo. A domesticated breed (of which a steer is exhibited in the North Hall, presented by Mr. C. B. Kloss in 1905) is kept in the small island of Bali, near Java, whence large numbers are exported to Singapore. The head of the black Javan wild Banting, presented by Baron Van Hockeren-tot-Walien in 1904, and one of the tawny Burmese Tsaine, presented by Mr. R. McD. Hawker in 1900, are exhibited in the Pavilion at the end of the Lower Mammal Gallery. [Lower Mammal Gallery, Cases 41 to 44, and North Hall.]

[Pavilion at end of Lower Mammal Gallery. Case 44.]

The Yak.
Bos [Poëphagus] grunniens.

This species (**1033**) is confined to the highlands of Tibet and adjacent regions, where it occurs both wild and in a more or less domesticated condition; tame Yak being largely employed as beasts of burden in that region. The wild race is always uniformly dark-coloured, but many of the domesticated animals show a considerable amount of white. The Yak appears to form a connecting link between the more typical Oxen and the Bisons; its skull showing many points of resemblance to the latter. Its large and wide-spreading horns are nearly cylindrical. The most distinctive feature of the species is the mass of long hair covering the flanks, limbs, and tail. The voice of the domesticated breed is a grunt. Yak are extremely impatient of heat, and in summer are found at elevations of from 14,000 to 20,000 feet. They feed on coarse wiry grass, and even when domesticated will not eat corn. Whereas the cows and young go about in large parties, the old bulls are solitary. The latter are very wary, and in the daytime generally rest on some exposed hill-side, where they rely chiefly on their keen sense of smell for protection. The tails of domesticated Yaks are used in India as fly-whisks, and are termed *chowris*. A fine series of skulls and horns, mainly presented by Mr. A. O. Hume, as well as a mounted head presented by Capt. H. Cock, and an entire skin, are exhibited. The entire skin is, however, that of a rather small animal.

The European Bison.
Bos [Bison] bonasus.

[Large Case (44) in Pavilion at end of Lower Mammal Gallery.]

In the general form of their horns and the structure of the skull, as well as in the possession of 14 or 15 pairs of ribs, the two species of Bison resemble the Yak rather than the typical Oxen; although their skulls are shorter and more convex than those of the former. They are remarkable for the great height of the fore-quarters, which form a kind of hump at the withers; and also for the mass of crisp dark brown hair covering the top of the head, neck and shoulders, and extending some way down the fore-limbs, and also along the back to the tail, which is thickly tufted at the tip. The European Bison, *Bos* [*Bison*] *bonasus* (**1034**), is a forest-dwelling species, now fast verging on extinction. It is still found in a wild state in the Caucasus, and in the forest of Bielowieza, Lithuania Government of Grodno), a herd has long been protected by the

Russian Government. In 1880 this herd numbered 600 head, but it has considerably diminished since that date. The species is represented by a bull from the Lithuanian herd presented by [Case 44.] H.I.M. the Tsar of Russia in 1845, and a bull and cow from the Caucasus, killed and presented by Mr. St. George Littledale in 1892. During the Pleistocene epoch (as well as later) the Bison was abundant over the greater part of Europe, but it appears to have become extinct in Britain much sooner than the Aurochs. The Pleistocene Bison is distinguished as *Bos* [*Bison*] *priscus*; a series of skulls is exhibited in the Geological Department.

The American Bison.
Bos [Bison] bison.

This species (**1035**), which is very closely [Case 44.] allied to the European Bison, although with more abundant hair, relatively weaker hind-quarters, and shorter and more curved horns, formerly existed in hundreds of thousands on the prairies of the North-West, but is now almost exterminated as a wild animal. A small herd is preserved by the U.S. Government in the Yellowstone Park and a few others exist under protection. Bison (or "Buffalo," as they are universally called in America) were typically inhabitants of the open prairies, and thus differed markedly from their European relative. During a large portion of the year they went about in small bands, but during the breeding-season collected in enormous herds. In search of water, they sometimes made long journeys across country; and all the various bands composing a herd migrated southwards in winter. The number of Bison in the great herd on the Arkansas in 1871 was computed at not less than four millions. An alternative name of the species is *B. americanus*.

The Wood-Bison, *Bos* [*Bison*] *bison athapascæ*, is a large dark-coloured race inhabiting the North-West districts, and dwelling in partially timbered country. Most or all of the survivors of the species belong to this race, which is very similar to the typical prairie race.

African Buffaloes.
Bos [Bubalus] caffer, etc.

The Buffaloes are heavily built Oxen, [Case 44.] with sparsely haired skin, large ears, long tufted tails, broad muzzles, and massive angulated horns. In having only 13 pairs of ribs they resemble the typical Oxen. African Buffaloes have the hair of the back directed backwards. In the Cape Buffalo, *Bos* [*Bubalus*]

[Cases 41 & 44.] *caffer* (**1037**), the horns do not attain an excessive length, but in old bulls are so expanded and thickened at the base as to form a helmet-like mass protecting the whole forehead. In Eastern Africa the Buffaloes (*B. caffer æquinoctialis*, **1038**) have smaller horns, which do not meet in the middle line; and other local races have been named. From the former, which is brown instead of black, there seems to be a transition towards the red Dwarf Buffalo (*B. nanus*, **1039**) of West Africa. In South Africa Buffaloes frequent reedy swamps, where they associate in herds of from fifty to a hundred or more individuals. Old bulls may be met with either alone or in small parties of from two or three to eight or ten. The typical Cape Buffalo, in addition to numerous skulls and horns, is represented by a male and female shot by Mr. F. C. Selous; while a male and female of the red Dwarf Buffalo are also shown, the former presented by Mr. C. Beddington in 1900.

Asiatic Buffaloes. In a wild state the typical form of the Indian Buffalo (*Bos* [*Bubalus*] *bubalis*, **1043**), seems to be restricted to India and Ceylon, although some of the Buffaloes found in the Malay Peninsula and Islands probably represent local races. The species has been introduced into Asia Minor, Egypt, Italy, and elsewhere. The large size and wide separation of the horns, as well as the less thickly fringed ears, and the more elongated and narrow head, form marked points of distinction between the Asiatic and the African species. Moreover, all Asiatic Buffaloes are distinguished from the African species by having the hair on the fore part of the back directed forward. The haunts of the Indian Buffalo are the grass-jungles near swamps, in which the grass exceeds twenty feet in height. Here the Buffaloes—like the Indian Rhinoceros—form covered pathways, in which they are completely concealed. The herds frequently include fifty or more individuals. These animals are fond of passing the day in marshes; they are by no means shy, and do much harm to the crops. There are at least two races of the Indian wild Buffalo; one, the ordinary form with much curved horns, and the other, *B. bubalis macrocerus*, with the horns extending almost straight outwards for the greater part of their length, and very long. Of this Assam race, now apparently extinct, the skulls and horns of a bull and cow are exhibited on the top of the Wild Ass

[Pavilion at end of Lower Mammal Gallery. Case 44.]

case; and a huge pair of horns—once the property of Sir Hans Sloane—on the south wall of the Pavilion. The Tamarao, or Philippine Buffalo (*B. mindorensis*, **1044**), is a smaller animal, in many respects intermediate between the Indian Buffalo and the Anoa, or dwarf Celebes Buffalo (*B. depressicornis*, **1045**).

The Anoa.

Bos [Bubalus] depressicornis.

As already mentioned, the Anoa (**1045**) of Celebes is the smallest and most aberrant of the Oxen. The horns are peculiar for their upright direction and comparative straightness, although they have the same triangular section as in the Buffaloes. White spots are sometimes present just below the eyes, and there may be white markings on the legs and back; this type of colouring is unlike that of other wild Oxen, and approximates to that of the Antelopes. The horns of the cows are very small. The nearest allies of the Anoa seem to be certain extinct Buffaloes of which the remains are found in the Siwalik Hills of Northern India. In habits the animal appears to resemble the Indian Buffalo. Young Anoas have thick woolly coats, frequently brown in colour, but the skins of the adults are nearly naked and black. [Case 44.]

Sheep.

Genus Ovis.

Together with the Goats, the Sheep form a subfamily (*Caprinæ*) of the *Bovidæ* differing from the Oxen (*Bovinæ*) by their slender hairy muzzles, and narrow upper molar teeth, which have no additional column on the inner side. They pass almost imperceptibly into the Goats. Both sexes usually possess horns, but those of the females are small. In the males the horns are generally angulated, and marked by fine transverse wrinkles; their colour being greenish or brownish. They are directed outwards, and curve in an open spiral, with the tips directed outwards. Although there may be a fringe of hair on the throat, the males have no beard on the chin; and they also lack the strong odour characteristic of the Goats. The upper lip of all Sheep has a vertical groove, connected with the bare skin of the nose. Usually the tail is short; and in all the wild species the coat takes the form of hair, and not of wool. Wild Sheep attain their maximum development, both in respect of number and size, in Central Asia. They associate either in large flocks, or in [Pavilion at end of Lower Mammal Gallery, & North Hall. Cases 46 to 48.]

family-parties; the old males generally keeping apart from the rest. Although essentially mountain animals, Sheep generally frequent open undulating districts, rather than the precipitous heights to which Goats are partial.

A number of breeds of domesticated Sheep are exhibited in the North Hall, among which special attention may be directed to one from the West Indies (originally a native of Africa) characterised by its hairy coat, the colour of which is very similar to that of the wild Urial Sheep of the Punjab exhibited in the Lower Mammal Gallery. Other breeds of *Ovis aries* (as domesticated sheep are called) are characterised by the development of a mass of fat on the buttocks, while in others, again, the long tail becomes flattened and loaded with fat. Specimens of both these breeds are shown. Yet other Sheep are distinguished by the development of an additional pair of horns; specimens of two distinct Four-horned breeds, one from the Hebrides and the other from South Africa, being exhibited. Very remarkable is the spiral-horned Wallachian Sheep (*O. aries strepsiceros*), characterised by the straight corkscrew-like spiral of the horns, as shown in a mounted ram. This type of horn passes, however, into the ordinary form, through breeds allied to the Indian Hunia Fighting-Sheep, of which a ram is shown.

The long tail of most breeds of tame Sheep is probably a result of domestication, as the Indian Urial and the Sardinian Mouflon, one or both of which probably represents the ancestral stock, are short-tailed.

[Pavilion at end of Lower Mammal Gallery. Cases 47 & 48.]

Bighorn Sheep.
Ovis canadensis, etc.

The Wild Sheep of the Rocky Mountains of North America locally known as the "Bighorn," and scientifically as *Ovis canadensis* (or *O. cervina*), is the type of a group of large Sheep characterised by the comparative smoothness of the strongly angulated horns, in which the outer front angle is very prominent, while the inner one is rounded off. The gland on the face is very small. The true Bighorn (**1052**) is a khaki-coloured Sheep with a large white rump-patch. The Black Bighorn (*O. stonei*, **1053**) of the Sticheen and Liard River districts is, on the other hand, a dark-coloured animal; while the White Bighorn (*O. dalli*, **1054**) of Alaska is almost pure white: both these having narrower and more pointed horns and smaller ears than the true Bighorn. The Grey Bighorn

(*O. fannini*, **1070**) of the Yukon is probably only a variety of the White Bighorn; and indeed it is a question whether any one of these Sheep is more than a local race of *O. canadensis*. The specimen of the Black Bighorn was presented by Mr. D. T. Hanbury; those of the White Bighorn by Mr. J. T. Studley; and those of the Grey Bighorn by Prince Colloredo Mannsfeld. In North-east Siberia the group is represented by the long-haired grey *O. borealis* (**1055**), of which a specimen presented by Mr. Talbot Clifton is exhibited, and in Kamchatka by *O. nivicola* (**1056**); both these being closely allied to the White and the Black American Bighorns. [Cases 47 & 48.]

Argali Sheep.
O. ammon, O. hodgsoni, etc.

The Central Asian Wild Sheep known as Argalis differ from the Bighorns by their strongly wrinkled horns, in which the outer front angle is much more pronounced. The gland

Fig. 6.

The Siberian Argali Sheep (*Ovis ammon*).

below the eye is also much larger, and there is consequently a deeper pit in the skull for its reception. The Siberian Argali (*O. ammon*, **1057**, figs. 6 & 8) lacks the ruff on the throat characterising [Case 46.]

[Case 46.] the Tibetan *O. hodgsoni* (**1058**). The former inhabits mountainous country at an elevation of from 3,000 to 4,000 feet, where the slopes are covered with thin forest; but the Tibetan Argali is found at elevations of over 13,000 feet on open and rolling country. Although the old males are very wary and difficult to approach, the females and young males wander in large herds, and exhibit much less wariness. The Siberian Argali is the largest of all the wild Sheep, and has the most massive horns. A mounted specimen in the summer coat, presented by Mr. St. George Littledale, and a head, the gift of Major C. S. Cumberland (fig. 8), as well as numerous skulls, are exhibited. An allied species is Littledale's Sheep (*O. littledalei*, **1059**) of the Kuldja district—represented by a head presented by Mr. Littledale—in which the shape and direction of the horns are different, while the muzzle is white. The Saiar Sheep (*O. sairensis*, **1060**) of the Saiar or Jair Mountains, is a white-muzzled species of smaller size, represented in the collection by three mounted examples shot and presented by Mr. Littledale.

FIG. 7.

Skull and Horns of Marco Polo's Sheep (*Ovis poli*).

Marco Polo's Sheep.
Ovis poli.

[Case 46.] This magnificent wild Sheep (**1061**) is nearly allied to the Argalis, from which it is mainly distinguished by the more slender and distinctly angulated horns of the rams, which form a very open spiral (fig. 7), and the colour of the coat. In habits it closely resembles the Tibetan Argali, but it frequents a less barren country than the latter, the undulating Pamirs being covered in summer with luxuriant grass. In Turki the males are called Kulja, or Gulja, and the females Arkar. The somewhat smaller Sheep from the Thian Shan range described as *Ovis karelini* is only a race of the Pamir species. Marco Polo's Sheep, which is

Fig. 8.

Head of the Siberian Argali Sheep
(*Ovis ammon*).

Fig. 9.

Head of the Thian Shan Ibex
(*Capra sibirica almasyi*).

(From specimens in the Museum.)

[*To face page* 24.

found on the Pamirs at a height of about 16,000 feet above the sea, is named after the great Venetian traveller, Marco Polo, who crossed the Pamirs during his journey through "Tatary" in the latter part of the 13th century. It was not, however, till 1838 that skulls were brought to England by Lieut. Wood, R.N., on the evidence of which the species was named *Ovis poli* by Mr. E. Blyth in 1840. The mounted male specimen was presented by Mr. Littledale; numerous specimens of the skull and horns are exhibited on the tops of the cases.

The Shapo, or Urial Sheep.
Ovis vignei.

The wild Sheep known in the Punjab as the Urial (**1063**), and in Ladak as the Shapo (*Ovis vignei*, **1062**), is a smaller animal than the Argalis, with less massive horns, and a ruff of long white hair on the throat of the males. It is remarkable on account of inhabiting countries with a widely different climate; the Urial being found in the hot hills of the Punjab at a few hundred feet above the sea-level, and the Shapo at elevations of from twelve to fourteen thousand feet in Ladak and other districts of Tibet. The female has small horns. Several local races of this handsome sheep are known; the range of the species covering a large area in Central Asia, from the frontiers of Persia through Baluchistan and Afghanistan to the Salt Range in the Punjab and Ladak on the Upper Indus. [Case 47.]

The Armenian Wild Sheep.
Ovis gmelini.

This species (**1064**) resembles the Urial in general size and colour, but has a much smaller ruff on the throat, which does not extend nearly so high up, while the spiral formed by the horns of the rams is twisted in the opposite direction. The does are hornless. The species ranges from Asia Minor to the Elburz Mountains in Persia, where there is a distinct local race, represented in the collection by a mounted head presented by the Hon. W. Erskine, after whom it has been named *O. gmelini erskinei* (**1065**). The wild Sheep of the Troödos Mountains of Cyprus (*O. ophion*, **1066**) is a small form of this species. [Case 47.]

The Mouflon Sheep.
Ovis musimon.

The Mouflon or Wild Sheep of Sardinia and Corsica, *O. musimon* (**1067**), is a small dark-coloured species, characterised by the general absence of horns in the females, and of a ruff on the throat of the males, as well as by the horns having the front outer angle much

[Case 47.] less developed and the wrinkles finer than in the Urial. The Mouflon is stated to have formerly inhabited Greece and Spain, but this requires confirmation. Mouflon associate in flocks of considerable size under the leadership of an old ram; but during the breeding-season they split up into small parties, each comprising a ram and several ewes. In some Mouflon the females have small horns; and it is not improbable that the Sardinian and Corsican representatives of the species are respectively distinguished by the presence or absence of horns in this sex. The adult ram exhibited was presented by Mr. Ford Barclay.

The Bharal or Blue Sheep.
Ovis nahura.

This Tibetan wild Sheep (**1068**), representing the subgenus *Pseudöis*, forms one of the connecting links between [Case 48.] the typical Sheep and the Goats; the horns of the rams being nearly smooth, with a rounded or sub-quadrangular section at the base, and the curvature of a peculiar form. The face has no gland below the eye, and there is consequently no depression in the same region of the skull. From the more typical wild Sheep this species is further distinguished by the greater relative length of the tail. Bharal are never found below an elevation of about 10,000 feet above the sea-level; and in summer usually ascend to between 14,000 and 16,000. In general habits, the Bharal is intermediate between other Sheep and the Goats; but the males lack the strong odour characteristic of the latter. The colouring, especially the black and white on the legs, is also of a goat-like type.

Barbary Wild Sheep, or Arui.
Ovis lervia.

Even more aberrant than the Bharal is the Barbary Sheep, Arui or Udad (**1069**), which is further noticeable [Case 48.] on account of being the only member of the family found in Africa. The skull and horns present a considerable general resemblance to those of the Bharal, but the throat, chest, and fore-limbs are clothed with a mass of long hair, and the length of the tail is considerably greater than in any other wild Sheep. The colour is uniform red. The Arui inhabits the dry southern slopes of the Atlas from Tunis to the Atlantic, but is unknown in the heart of the range. In the Sudan it is found on the mountains nearly as far south as Khartum. It is capable of going for several days without water, and is difficult to detect owing to the

close resemblance of its tawny coat to the limestone rocks of the district. The species alone represents the subgenus *Ammotragus*. The specimen exhibited was presented by Sir E. G. Loder.

Goats.

Genus Capra.

By means of the Bharal Sheep (*Ovis nahura*) and Pallas's Ture or Goat (*Capra cylindricornis*), the Sheep and Goats are so closely connected that it is almost impossible to draw a satisfactory line of distinction between them. The males of the latter have, however, a strong odour, and carry a beard of variable size on the chin. None of the Goats possess a gland beneath the eye—a character which they have in common with the goat-like Sheep. The horns of the males are long, and generally more or less compressed or angulated; and in many species they bear prominent knobs on the front surface. In some kinds they are spirally twisted, and in others scimitar-shaped. In the wild species the females have small horns placed wide apart. The groove on the upper lip is less marked in some species than in Sheep. Goats differ from Sheep in selecting for their habitation the most precipitous and rugged mountains, and are absent from open elevated districts like the Pamirs of Central Asia. [Lower Mammal Gallery. Case 46.]

Ture, or Caucasus Goats.

C. cylindricornis & caucasica.

The two species of wild Goats—locally known as Ture, or Tur—inhabiting the Caucasus Mountains serve to connect the Bharal with the true Ibex. The more Bharal-like species, known to sportsmen as the Caucasian Bharal, and zoologically as Pallas's Ture (*Capra cylindricornis*, **1080**), is from the Eastern Caucasus; while *C. caucasica* (**1081**) of the Western and Central Caucasus, commonly known as the Caucasian Ibex, is the one which comes nearer to the Ibex. The former species is a brown animal with a short curling head, and blackish, smooth, sub-cylindrical, Bharal-like horns. The latter, on the other hand, is of a uniformly chestnut-red colour, with heavily knotted and upwardly directed Ibex-like horns which form very striking trophies. The mounted adult male specimen of the West Caucasian Ture was presented by Mr. St. George Littledale. [Cases 48 & 49.]

The Wild Goat.

Capra hircus ægagrus.

The Pasang, or Wild Goat (**1082**), is the ancestral stock from which the various domesticated breeds of Goats are mainly derived. The species is characterised by the scimitar-like horns of the males being compressed, and sharply keeled in front; the [Case 50.]

front keel bearing irregular prominences and notches. In Europe this Goat was formerly abundant in the Grecian Archipelago, although it now remains only in Crete and Antimilo. It is one of the most active of the Goats, taking leaps of great length with unerring precision. One animal that missed its foothold and fell, is recorded to have saved itself by falling on its horns. In Sind and Baluchistan Pasang are found on barren, rocky hills, but in Asia Minor they frequent forest-clad slopes. The Sind race is distinguished as *C. hircus blythi* (**1083**)—commonly known among sportsmen as the Sind Ibex; and the small Cretan race as *C. hircus cretensis* (**1084**).

[North Hall.]

Numerous breeds of domesticated Goats (*C. hircus*)—some represented by animals that have reverted to a wild condition—are exhibited in the North Hall. Among these, the Angora breed is famed for the length and silkiness of its long white coat; while the brown Sudan, or Theban, breed is noteworthy for the absence of horns in both sexes and its general Sheep-like appearance. The Goats that have run wild in the Azores are remarkable for the straightness and close approximation of their long horns; a skull and horns (presented by Major Chaves) are shown.

[Lower Mammal Gallery. Case 51.]

Ibex.

Capra ibex, etc.

The true Ibex are represented by four very closely allied species; viz.: *C. ibex* (**1085**) of the Alps, *C. sibirica* (**1086**) of the Himalaya, Thian Shan, and Siberia, *C. nubiana* (**1087**) of Arabia and Upper Eygpt, and *C. walie* (**1088**) of Abyssinia. Most are characterised by their more or less uniform coloration, and by the long scimitar-like horns having their front surface broad, flattened, and ornamented by a number of bold transverse knots, or ridges. As a wild animal the Alpine Ibex, or Steinbok, is now nearly exterminated, although some herds are preserved in one or two valleys on the Piedmont side of Monte Rosa. The Himalayan, or Siberian Ibex is a larger animal, with longer horns and a fuller beard. It is represented by several local races, such as the one from the Thian-Shan (fig. 9). The other two species are distinguished by the form of their horns. Ibex inhabit crags and upland grazing-grounds near the snow-level, descending to lower elevations in winter, and sometimes coming near the neighbourhood of villages. Although they occasionally congregate in large numbers, they are usually found in flocks of from six to about twenty head.

Fig. 10.

The White-maned Serow or Goat-Antelope (*Nemorhædus argyrochætes*).

(From a specimen in the Museum.)

[To face page 20.

The Markhor. Capra falconeri. In this very variable species of wild Goat (**1089**) the horns are twisted in a complete spiral and the beard extends on to the chest and shoulders. At least four different types of horns are recognisable representing as many local races. The race in which the horns are most divergent and their spiral most open inhabits Astor and Baltistan, while the one with the most upright and closely twisted horns is found in the Suleiman range of the Punjab. In habits Markhor resemble other Wild Goats; but whereas the open-horned varieties inhabit lofty pine-clad ranges, the one with closely twisted horns is found among low barren hills where the summer heat is intense. Many domesticated Goats have horns very similar to those of the Markhor, although the spiral almost invariably runs in the opposite direction. [Case 50.]

Tahr. Genus Hemitragus. The Himalayan Tahr (*Hemitragus jemlaicus*, **1099**), the smaller Arabian Tahr (*H. jayakari*, **1100**), and the Nilgiri Wild Goat or Ibex (*H. hylocrius*, **1101**), form a group differing from the true Goats by their smaller horns, the absence of a beard in the males, and their longer and narrower skulls. The horns of the females are but little smaller than those of the males. The Himalayan species inhabits the outer ranges of the Himalaya where forest is abundant; females frequenting more open ground than males. The old males keep apart from the females during the summer, and are found in districts where precipitous cliffs are numerous. They are consequently some of the most difficult of all animals to stalk. [Case 51.]

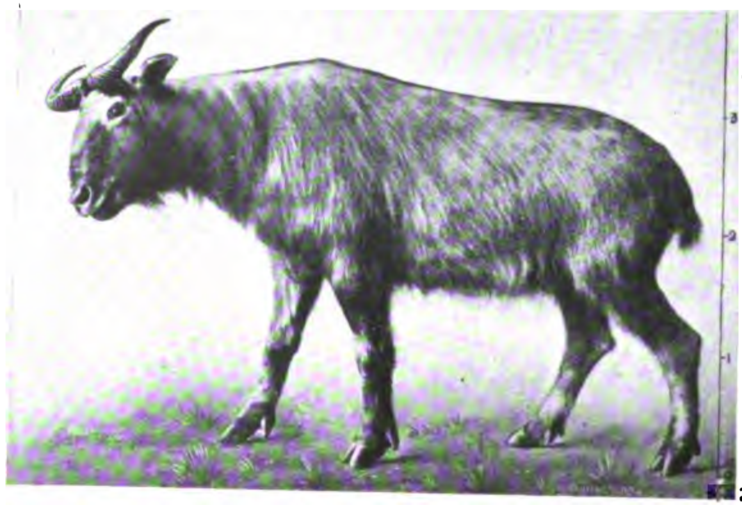
Serow, or Goat-Antelopes. Genus Nemorhædus. The Asiatic Serows belong to a group (*Rupicaprinæ*) showing affinity with the Antelopes on the one hand and the Goats on the other. Most of the group have short tails, relatively small cylindrical black horns, and the chin devoid of a beard. The Serows, which include some of the largest members of the group, inhabit hilly districts, and, although awkward in gait, are unrivalled in getting over bad ground. The Himalayan species, *Nemorhædus bubalinus* (**1104**), represented by a specimen presented by Dr. W. T. Blanford, is a solitary animal, nowhere numerous; two or three being found on one hill, and three or four on another. It prefers the rockiest and steepest hill-sides: [Case 52.]

[Case 52.] and its favourite resting places are under overhanging rocks or in caves. The Sumatran *N. sumatrensis* (**1107**) is nearly allied, and very probably only a local race. The white-maned *N. argyrochætes* (**1106**, fig. 10) of Central China is noticeable for its brilliant colouring. Other species occur in Tibet and the Malay Peninsula.

Gorals. Genus Urotragus, or Cemas. The Asiatic Gorals are nearly allied to the Serows, from which, in addition to certain peculiarities in the form of the skull, they are chiefly distinguished by possessing a gland below each eye, and a corresponding depression in the skull. Several species are known. Of these, the Brown Himalayan Goral (*U. goral*), commonly found in small parties, but sometimes in pairs, usually frequents grassy hills, or rocky ground clothed with forest; in fine weather feeding only in the mornings and evenings, but when the sky is cloudy grazing throughout the day. The Grey Himalayan Goral (*U. bedfordi*, **1110**) is nearly allied; and the group is represented in Burma by *U. evansi*, and by other species in Tibet. In common with Serows, Gorals have the cannon-bone long and slender in both the front and the hind limbs.

The Chamois. Genus Rupicapra. The Chamois, Gems, or Izard—as it is called in various parts of Europe—(*Rupicapra tragus* or *R. rupicapra*, **1113**), is the typical representative of the group of Goat-like Antelopes, or *Rupicaprinæ*, and differs from all the others by the distinct hook formed by the tips of the black horns. Chamois inhabit most of the mountain-ranges of Central and South Europe, the Pyrenean form (Izard) being a smaller animal, with shorter horns and a more foxy-red colour than the typical Gems of the Alps. They are generally found in the highest Alpine forests, although during summer a certain number of individuals leave the main flock to spend a few weeks or months among the snow-fields and glaciers. As a rule, Chamois associate in flocks of from fifteen to twenty head; but for most part of the year the old bucks live apart from the does. Their food consists of the scanty mountain-herbage and lichens. Generally the female gives birth to a single offspring, although there may be a pair. The young are able to follow their parents almost anywhere when but a day old.

Fig. 11.



The Tibetan Takin (*Budorcas taxicolor tibetanus*).

(From a specimen in the Museum.

[To face page 31.

The Rocky Mountain Goat. Genus Oreamnus. This Ruminant, *Oreamnus montanus* (**1114**), is remarkable for its pure white coat—a type of coloration very rare among Mammals. During the winter the hair is very long and straight, but in summer is replaced by a much shorter coat. The jet-black horns are very similar to those of the Serows, but behind each is a large globular gland. There is no gland beneath the eye. The cannon-bone in each leg is remarkably short and broad. Although universally known as the Rocky Mountain Goat, the animal is not a Goat in the proper sense of the term; being intermediate between the true Goats and the Antelopes. It is generally found above or close to the upper limits of forests; and although active and agile in climbing, has but little speed. During the warmer part of the year these animals are found alone or in small parties, but in the late autumn and winter they congregate in flocks of considerable size. They are far less shy and wary than most mountain mammals, and are consequently not difficult to stalk. [Case 52.]

The Takin. Genus Budorcas. The Takin, *Budorcas taxicolor* (**1118**), of the Mishmi Hills, north of the Assam Valley, is a clumsily built Ruminant resembling the Rocky Mountain Goat in its short and broad cannon-bones, and probably nearly related to that animal, and more remotely to the Serows. From both it is distinguished by the form of its horns, which, after bending downwards and outwards for a short distance, suddenly change their direction and point backwards. Beyond the fact that it is a native of extremely elevated regions in Tibet, nothing has been ascertained with regard to the habits of this Ruminant. The typical Mishmi Takin is mainly a brown animal; but in the Tibetan Takin (*B. taxicolor tibetanus*, **1119**, fig. 11), of Eastern Tibet and North-West China, the colour of much of the long hair is golden yellow. Specimens of the two races are shown. [Case 53.]

The Musk-Ox. Genus Ovibos. The Musk-Ox (*Ovibos moschatus*, **1047**, fig. 12), which approaches the smaller Oxen in point of size, is probably a relative of the Takin and the Rocky Mountain Goat, with which it agrees in the short cannon-bones. The animal derives its name from the strong musky odour it exhales. A very characteristic feature of the Musk-Ox is to be found in the form of the horns, which are much flattened at their [Pavilion at end of Lower Mammal Gallery. Case 45.]

broad bases, and in old males almost meet one another in the middle line of the skull. As in the Sheep and Goats, most of the muzzle is hairy, and thus very different from the same part in the Oxen, but the upper lip is not grooved. The matted hair of the body is of great length and thickness. Musk-Oxen associate in flocks, usually numbering from twenty to thirty head, although occasionally much more numerous. In habits they are very similar to Sheep; and in the breeding-season the old males fight together with great ferocity. The single offspring is born in May or June. During the Pleistocene epoch the Musk-Ox wandered over Britain and much of the rest of Northern and Central Europe. Two local races exist, the typical North American Musk-Ox and the Greenland Musk-Ox (*O. moschatus wardi*, **1048**), the latter distinguished by the presence of white hair on the forehead. Mr. D. T. Hanbury is the donor of one of the mounted male specimens of the typical race, while the example of the Greenland race was presented by Mr. Rowland Ward.

FIG. 12.

The Musk-Ox (*Ovibos moschatus*).

[West Corridor.]

Bushbucks. Genus Tragelaphus. With the Bushbucks (*Tragelaphus*) we come to the first representatives of that indefinable assemblage of Ruminants collectively designated Antelopes, of which there are several subfamilies: the Bushbucks, or Harnessed

Fig. 13.

Head of the Situtunga Antelope
(*Tragelaphus [Limnotragus] spekei*).

Fig. 14.

Head of the Bongo Antelope
(*Böocercus euryceros*).

(From specimens in the Museum.)

Antelopes, together with the Bongo (*Böocercus*), the Elands (*Taurotragus*), Kudus (*Strepsiceros*), and the Indian Nilgai (*Boselaphus*), constituting the *Tragelaphinæ*, and collectively presenting the following characteristics. Except in the Elands and Bongo, horns are present only in the males, and these are angulated, generally spirally twisted, and without rings. The muzzle is naked, small glands are present on the face below the eyes, and the tail is comparatively long. The Bushbucks are closely allied to the Kudus, from which they chiefly differ by the spiral formed by the horns generally having fewer turns. Many of them, such as the widely spread *T. scriptus* (**1201**), are brilliantly coloured, the ornamentation taking the form of vertical white lines and rows of spots; and in some cases the sexes often differ in colour, as in the Nyala (*T. angasi*, **1202**). Most of the species have hoofs of normal shape, but in some, such as the Situtunga, or Nakong, *Tragelaphus* [*Limnotragus*] *spekei* (**1203**, fig. 13), these are elongated, so as to be adapted for walking in soft mud; that animal spending most of its time in water, where it stands among reeds with all but its head and horns submerged.

[West Corridor.]

[Case IV.]

[Case V.]

The Bongo. Genus Böocercus.

The Bongo (*Böocercus euryceros*, **1204**, fig. 14), of which there is a western and an eastern race, differs by having horns in both sexes, as well as by the tufted tail. It is even more brilliantly coloured than the Bushbucks. The entire specimen exhibited belongs to the eastern race, *B. e. isaaci* (**1205**), and was obtained by Mr. F. W. Isaac, the discoverer of this race.

Kudu. Genus Strepsiceros.

[Case 9.]

The two species of Kudu (*Strepsiceros*) are nearly allied to the Bushbucks on the one hand, and to the Elands on the other. From the former they are distinguished chiefly by the more numerous turns in the spirals of the horns of the male; from the latter they differ—among other features—by the much more open spiral formed by the horns of the male, and the absence of these appendages in the female. Both species are characterised by the narrow vertical white stripes on the body and the white markings on the face. The Greater or true Kudu (*Strepsiceros kudu*, *capensis*, or *strepsiceros*, **1206**, fig. 16), was formerly widely distributed in South and East Africa, but in many districts its numbers have now been greatly reduced. It is very generally found in hilly country densely covered with thickets, but

it also occurs in thin bush along the banks of rivers, as well as in thorn-jungles on the plains. Kudu associate either in pairs, or in small parties. Their speed is not great. When pursued, they always make for hilly ground. The Lesser Kudu (*S. imberbis*, **1207**) is a much smaller species, distinguished by the absence of a fringe of long hair on the throat, and also by the closer spiral formed by the horns of the males (fig. 15). The range of the Greater Kudu extends from South Africa to Somaliland, where it is represented by a local race, *S. kudu chora*. The Lesser Kudu is confined to East and North-East Africa. The exhibited specimen of the Greater Kudu was shot by Mr. F. C. Selous.

Eland. -Genus Taurotragus. Elands, the largest of Antelopes, are divided into two species—one (*T. oryx*, **1208**) from South and South-East Africa, the other (*T. derbianus*, **1209**) from West and Central Africa. Nearly allied to the Kudus in the structure of their skulls and the form of their horns and cheek-teeth, they are specially distinguished by the close spiral formed by the horns, which are present in both sexes. In females the horns are longer and more slender than in males. There are three races of the Common Eland, in one of which the body is uniformly coloured, while in a second, *T. oryx livingstonei*, it is marked by narrow vertical white lines. The third race, *T. o. pattersonianus* (**1210**), of British East Africa, approximates so much to the northern Elands as to suggest that all are really one species. There are two races of *T. derbianus*; the Giant Eland, *T. derbianus gigas*, of the Bahr-el-Ghazal, being the largest of all. *T. derbianus* is characterised by the dark brown neck of the bulls and the white chevron on the forehead. The exhibited specimens of Livingstone's Eland were shot by Mr. F. C. Selous in Mashonaland.

[West Corridor. Case XII.]

These animals go about in large herds, and are found alike in desert and wooded districts, and on hills and plains. Although where water is abundant they drink regularly, in parts of the Kalahari Desert the only fluid they obtain is derived from water-melons. They are generally accompanied by Rhinoceros-birds, which give the alarm when danger is at hand. Elands are now exterminated from the Cape, Natal, the Orange River Colony, Griqualand West, and the Transvaal.

Fig. 15.

Skull and Horns of the Lesser Kudu (*Strepsiceros imberbis*).

Fig. 16.

Skull and Horns of the Kudu (*Strepsiceros kudu*).

(From specimens in the Museum.)

Fig. 17.

Horns of the Gemsbuck (*Oryx gazella*).

[*To face page* 34.

Fig. 18.

Head of the Nilgai or Blue Bull (*Boselaphus tragocamelus*).
(From a specimen in the Museum.)

[*To face page* 35.

The Nilgai. Genus Boselaphus. The Nilgai or Blue Bull, *Boselaphus tragocamelus* (**1120**, fig. 18), of India, alone represents a genus allied to the Bushbucks, but distinguished by the much simpler form of the horns of the males, which are smooth, short, and nearly straight, with a distinctly triangular section at the base, but becoming circular near the tips. The coloration too, is of a different type, the body being nearly uniform bluish grey, while there are white markings on the ears, face, and throat, and white rings above the fetlocks. In build, the Nilgai is a somewhat ungainly creature, owing to the excessive length of the fore-limbs. These Antelopes are found both on the plains and in low hills, generally preferring districts covered with thin bush, or alternations of grassy plains and low jungle. Owing to their being held sacred by the Hindus, they are excessively bold in many districts, and wander through the cornfields where men are at work. The bulls are generally solitary, although occasionally a small number congregate together; but the cows and calves are found in parties usually varying from four to ten in number, although in rare cases containing from fifteen to more than a score. [Lower Mammal Gallery. Case 53.]

The Sable Antelope Group. Genus Hippotragus. The Sable Antelope (*Hippotragus niger*, **1188**) and the Roan Antelope (*H. equinus*) belong to a genus nearly related to the Oryxes, with which they form a group, or subfamily. In all these Antelopes long cylindrical horns are present in both sexes; the muzzle is hairy; there is no gland below the eye; the tail is long and tufted; and in the breadth of their tall crowns the upper molar teeth resemble those of the Oxen. The Sable Antelope and its allies (*Hippotragus*) are specially distinguished by the stout and thickly ringed horns rising vertically from a ridge over the eyes at an obtuse angle to the plane of the lower part of the face, and then sweeping backwards in a bold curve. Sable Antelopes are some of the handsomest of the South African Antelopes, and are also endowed with great speed and staying power. They are commonly met with in herds including from ten to twenty individuals, but on rare occasions as many as fifty have been seen together. Forest-clad highlands are their favourite resorts. The Roan Antelope is a larger and lighter-coloured species, with a much wider range, being represented in the Sudan by a separate race (*H. equinus bakeri*, **1189**). [West Corridor. Case XI.]

[West Corridor. Case X.]

The Addax Antelope. Genus Addax. The Addax (*Addax nasomaculatus*, **1190**), of North Africa and Syria, is a near relative of the Antelopes of the genus *Hippotragus*, from which it differs structurally by the horns forming an open spiral, ascending nearly in the plane of the face, these being ringed for the greater part of their length. The forehead, neck, throat, and shoulders are clothed in winter with long shaggy hair. In habits, the Addax is very similar to the Oryxes, dwelling in deserts, and being apparently independent of water; its pale colouring, especially in summer, is an adaptation to desert life.

[Cases VII & X.]

The Oryx Group. Genus Oryx. The Gemsbuck (*Oryx gazella*, **1191**) of South Africa, with certain allied species, constitutes a genus nearly allied to *Hippotragus*, but distinguished by the straight or recurved horns (fig. 17) sloping backwards more or less nearly in the plane of the face. Oryx, as these Antelopes are collectively called, are found throughout the desert-tracts of Africa, and also in Arabia and Syria. The Gemsbuck (*O. gazella*) is a South African species; in Abyssinia and Somaliland it is replaced by the Beisa Oryx (*O. beisa*, **1192**), in which the black markings have a different arrangement; while in East Africa it is represented by the Fringe-eared Oryx (*O. callotis*, **1193**). The Scimitar Oryx (*O. algazal*, **1194**) is from North-Eastern Central Africa. Oryx are desert Antelopes, generally found in herds of considerable size, although the old males sometimes separate from the others. They are independent of water, and flourish where the vegetation is scanty. The Gemsbuck has been known to kill the Lion by transfixing it with its horns.

[Lower Mammal Gallery.]

The Gazelles. Genus Gazella. The Gazelles form the largest genus of the subfamily *Antilopinæ*. The subfamily is characterised by the narrow crowns of the molars, which are similar to those of the Sheep, and the hairy muzzle. Generally there are face-glands below the eyes; and the tail is moderate or short. Pits are present in the forehead of the skull, and the horns are ringed for part of their length, with a compressed base; their form being often lyrate, but sometimes spiral. Gazelles inhabit open, and frequently more or less desert districts. They are mostly of a sandy colour, with dark and light markings on the face, and often a dark band on the flanks. The horns are more or less lyrate, and

Fig. 19.

Head of Grant's Gazelle
(*Gazella granti*).

Fig. 20.

Head of the Gerenuk
(*Lithocranius walleri*).

(From specimens in the Museum.)

[To face page 97.

generally developed in both sexes; there are frequently brushes of hair on the knees. Gazelles may be divided into groups. The one to which the Arabian *Gazella dorcas* (**1130**) belongs is characterised by the presence of lyrate or sub-lyrate horns in both sexes, and by the white of the buttocks not extending on to the haunches. Nearly allied is the group including the Indian *G. bennetti* (**1131**) and the Arabian *G. arabica* (**1132**), in which the horns have a somewhat **S**-shaped curvature in profile. In the African group, represented by *G. granti* (**1133**, fig. 19), *G. thomsoni* (**1134**), *G. mohr* (**1135**), etc., the white of the buttocks often sends a prolongation on to the flanks, the horns are long, and the size is large. *G. gutturosa* (**1136**), *G. subgutturosa* (**1137**), and *G. picticaudata* (**1138**), form an Asiatic group in which the females are hornless, and the face-markings inconspicuous or wanting. The series of Gazelles exhibited is too large for detailed notice. [Lower Mammal Gallery. Cases 54–56.]

The Springbuck. Genus Antidorcas. The Springbuck (*Antidorcas euchore*, **1122**) is nearly related to the Gazelles, from which it is distinguished by the presence on the middle of the loins of an eversible pouch, lined with long white hairs capable of erection. It has also one premolar tooth less in the lower jaw. Formerly these beautiful Antelopes existed in countless numbers on the plains of South Africa, and were in the habit of migrating in droves which completely filled entire valleys. Now they are comparatively rare. They derive their name from their habit of often leaping high in the air when on the move—a habit shared with the Indian Blackbuck. Like the next four Antelopes, the Springbuck represents a genus by itself. [Case 54.]

The Dibatag. Genus Ammodorcas. The Somali Dibatag, or Clarke's Gazelle, *Ammodorcas clarkei* (**1121**), forms a kind of connecting link between the Gazelles and the Gerenuk; this being especially shown in the skull. The face shows the ordinary Gazelle-markings; but the rather short horns—which are wanting in the female—have a peculiar upward and forward curvature, quite unlike that obtaining in the true Gazelles, and somewhat resembling those of the Reedbuck. The neck is longer and more slender than in ordinary Gazelles, and the tail is likewise relatively long. Although local, these animals are fairly common in the interior of [Case 54.]

Somaliland, where they are known by the name of Dibatag. In running, the head and neck are thrown backwards, while the tail is turned forwards over the back.

The Gerenuk. Genus Lithocranius. The East African Gerenuk, or Waller's Gazelle, *Lithocranius walleri* (**1125**, figs. 20–22), differs from ordinary Gazelles not only by its exceedingly elongated neck and limbs, but likewise by the peculiar hooked form of the very massive horns of the bucks, the dense structure and straight profile of the skull, and the extreme slenderness of the lower jaw. In Somaliland Gerenuk are found in small family-parties, and feed more by browsing on the branches and leaves of trees and shrubs than by grazing. Frequently they raise themselves by standing on their hind-legs with the fore-feet resting against the trunk of the tree on which they are feeding. Their usual pace is an awkward trot, not unlike that of a Camel; and they seldom break into a gallop. [Case 54.]

The Beira Antelope. Genus Dorcatragus. The Beira, *Dorcatragus megalotis* (**1128**), of Somaliland and the adjacent districts, is quite a small Antelope, which presents many points of resemblance to the Dik-diks and their allies, although structurally it appears to be more nearly related to the Gazelles. [Case 54.]

The Blackbuck. Genus Antilope. As now restricted, the genus *Antilope* includes only the Blackbuck, or Indian Antelope, *Antilope cervicapra* (**1145**), a species characterised by the beautiful spiral twist of the horns of the bucks, and the dark colour of the hair of the upper-parts in adult members of the same sex. The glands below the eyes are very largely developed; and there are tufts of hair on the knees, and lateral hoofs to the feet. Blackbuck are found on the open plains of India, from the foot of the Himalaya nearly to Cape Comorin; they frequent both grassy districts and corn-lands. Although the usual number in a herd varies from ten to thirty, or fifty—among which there often will be only a single fully adult sable buck—in some cases the assemblage may include hundreds, or even thousands of individuals. These Antelopes possess great speed, and when running frequently progress by a series of long leaps. In many districts they will allow carts, or even men, to approach very close. [Case 56.]

Male and Female Gerenuk (*Lithocranius walleri*).
(From specimens in the Museum.)

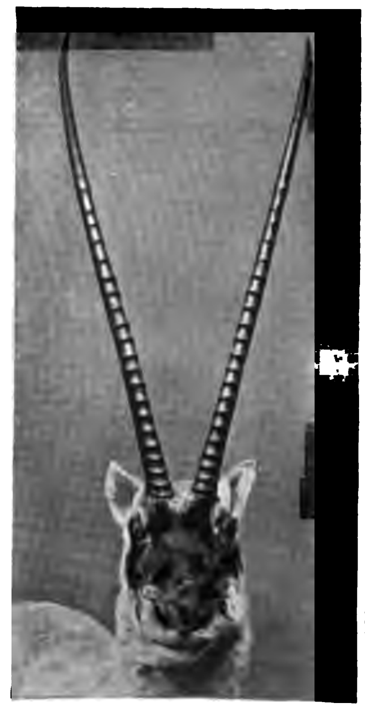
Engraved Outline on Slate of Gerenuk from Lower Egypt; discovered by Prof. Flinders Petrie, and believed to date from 5600 B.C.

[*To face page* 38.

Fig. 23.

Head of the Palla Antelope
(*Æpyceros melampus*).

Fig. 24.



Head of the Chiru Antelope
(*Pantholops hodgsoni*).

The Palla Antelope. Genus Æpyceros. The South-African Palla, or Impala, *Æpyceros melampus* (**1123**, fig. 23), is the typical representative of a genus belonging to the group *Antilopinæ*, and containing two species. Pallas are distinguished by the lyrate, widely divergent, and somewhat spiral horns of the bucks, and the absence of lateral hoofs to the feet, and of glands on the face, as well as by the presence of a pair of glands, marked by black tufts, on the hind surface of the hind-feet. The does are hornless. The common species inhabits South and South-Eastern Africa, and is represented by a small race in Nyasaland; the second species (*Æ. petersi*, **1124**) being from Angola. Pallas associate in herds, including from twenty to one hundred individuals, the majority of which are usually females. They are seldom found far away from water, and often frequent sandy plains covered with mimosas and low scrub near rivers. In speed they surpass all other African Antelopes, and their leaping powers are described as marvellous. [Case 54.]

The Chiru Antelope. Genus Pantholops. The Tibetan Antelope, or Chiru, *Pantholops hodgsoni* (**1144**, fig. 24), is the sole member of a genus apparently nearly allied to the Saiga, but well distinguished by the long black horns of the bucks, and the less convex nose, in which the nostrils open anteriorly instead of downwards. Chiru are inhabitants of the desolate open plateau of Tibet, at elevations of between 13,000 and 18,000 feet above the sea-level. To withstand the intense winter cold of those districts, the body is covered with an extremely thick coat of soft fur, which assumes a woolly texture at the base. Generally Chiru are found in small parties, although they occasionally congregate in herds. [Case 56.]

The Saiga Antelope. Genus Saiga. The Saiga Antelope, *Saiga tatarica* (**1146**, fig. 25), which alone represents the genus of the same name, is a desert-dwelling Antelope, easily recognised by its extraordinary swollen and puffy nose, in which the apertures of the tubular nostrils are directed downwards. The horns of the males are peculiar for their yellowish colour, and the wide distance they are set from one another on the head. There is a small gland on each side of the face below the eye; and the ears are remarkable for their short and rounded form. At the [Case 56.]

present day the headquarters of this Antelope are the Kirghiz Steppes, but a century ago its range extended as far west as Poland. During the latter part of the Tertiary period the Saiga was much more widely distributed, its fossilised remains having been obtained from many parts of Western Europe, including Britain. Saigas associate in large herds; and although they run swiftly for a short distance, they soon tire, and are thus easily captured. The tubular nose, which can be shortened by being wrinkled up, may be a provision to prevent particles of sand being carried up into the nose-chamber. The specimens exhibited were presented by the Duke of Bedford.

The Pigmy, or Royal, Antelope. Genus Neotragus.

[Case 56.]

The genus *Neotragus*—of which the Pigmy or Royal Antelope, *Neotragus pygmæus* (**1154**), is the typical representative, brings us to a group which includes a number of allied species arranged in the genera *Oreotragus*, *Oribia*, *Raphiceros*, *Nesotragus*, *Hylarnus*, and *Madoqua*. All these Neotragine Antelopes are of small size. They may have the muzzle short and naked, or elongated and hairy; but the gland below the eye is always large, and opens by a small circular orifice. The tail is either short or of medium length; and lateral hoofs may be present or absent. The horns—which are present only in the males—are short, and more or less nearly straight, with ridges at the base, but smooth at the tip; their direction being either vertical or inclining backwards. From the following genera, *Neotragus* differs by the very small size of the horns of the males, which do not reach within some distance of the back of the skull; and likewise by the absence of any vacuities between the bones of the face. Two allied species, one from West Africa and the other from the Ituri Forest, have been named *Hylarnus*.

The Suni Antelopes. Genus Nesotragus.

[Case 56.]

The two East African species of this genus, the Suni, or Zanzibar Antelope, *Nesotragus moschatus* (**1155**), and *N. livingstonianus* (**1156**), are somewhat larger than the Pigmy Antelope, with relatively longer horns, which are inclined backwards nearly in the line of the face, and reach at least as far as the back of the skull. As in the Pigmy Antelope, there are lateral hoofs to the feet, but no bare glandular patches behind the ear. In addition to inhabiting the mainland, the Zanzibar Antelope is found on two small coral-

FIG. 25.

THE SAIGA ANTELOPE (*Saiga tatarica*).

(From a specimen presented by the Duke of Bedford, K.G.)

[To face page 40.

islands at the entrance to the harbour of Zanzibar, where it can obtain no water, except such rain or dew as may fall on the leaves, for many months. In these islands the Antelopes live entirely on leaves and twigs of trees and scrub, never touching the wiry grass with which parts are covered.

The Grysbok and the Steinbok. Genus Raphiceros. From the other members of the *Neotraginæ* with naked muzzles and no glandular spot below the ear, the Grysbok, *Raphiceros melanotis* (**1157**), and the Steinbok, *R. campestris* (**1158**), are distinguished by the nearly vertical direction of the horns; while they are further characterised by the small size of the depression in the skull for the reception of the gland below the eye. The Grysbok possesses lateral hoofs, but these are absent in the Steinbok. The Steinbok is one of the most common Antelopes of South Africa, frequenting the open plains either singly or in pairs. It commences feeding about sundown, and continues its wanderings through the night, retiring to the cover afforded by a bush or patch of tall grass for repose during the day. These Antelopes run with great speed. There is more than one species of Steinbok. [Case 56.]

The Oribi Antelopes. Genus Oribia, or Ourebia. The species of Oribi, as typified by the South African *Oribia oribi* (**1160**), differ from the other *Neotraginæ* with pointed hoofs and naked muzzles by the presence of a bare glandular spot below each ear. As additional distinctive features, may be noticed the presence of lateral hoofs, and the large size of the depression in the skull for the gland below the eye. The horns are generally about three-quarters the length of the skull, and have a variable number of ridges at the base. Oribis are inhabitants of open country, and abundant in South and East Africa. Although absent from the West Coast and the Congo districts, they reappear in the open country of Gambia and Senegal, where they are represented by *O. nigricaudata* (**1161**). In the South African Oribi there are tufts of long hair on the knees, which are wanting in the Gambian species. [Case 56.]

The Dik-dik Antelopes. Genus Madoqua. The various East and North-East African small Antelopes known as Dik-diks differ from the other members of the *Neotraginæ* by their elongated and hairy noses, and likewise by the tuft of [Case 56.]

hair on the crown of the head. The tail is so short as to be almost rudimentary, and the lateral hoofs are very minute. The species, something like half-a-dozen in number, fall into two groups. In the first of these the development of the nose is not very excessive, and the last lower molar tooth wants the third lobe found in all other Ruminants. In the second the nose is so large as to be almost trunk-like, and the third lower molar is normal. Salt's Dik-dik, *Madoqua saltiana* (**1164**), belongs to the first, and Günther's Dik-dik, *M.* [*Rhynchotragus*] *guentheri* (**1165**), to the second group. Salt's Dik-dik—the Beni Israel of the Arabs—abounds on the Red Sea littoral and in the hotter districts of Abyssinia. It inhabits bushes, keeping much to thick covert on the banks of water-courses; and is usually seen singly, or in pairs, either a male and female, or a female and young being found together. More rarely a female is accompanied by two young, which remain with her till nearly full grown.

The Klipspringer. Genus Oreotragus. [Case 56.] The African Klipspringer, *Oreotragus saltator* or *O. oreotragus* (**1166**)—which alone, with several local races, represents the genus *Oreotragus*—differs from the other *Neotraginæ* by the blunted, cylindrical hoofs, and the thick, pithy hair, which is very similar to that of the Musk-Deer. The horns, which are developed only in the male, rise vertically from the short skull. The Klipspringer derives its name ("Rock-jumper") from its habit of leaping from rock to rock in the rugged districts where it dwells. It always stands on the tips of its hoofs, and when alighting from a spring will frequently perch on a pinnacle of rock so small as to only just afford room for its feet, which are then crowded together. These Antelopes are generally found in pairs, and never associate in flocks. Although no longer met with in the immediate vicinity of Cape Town, they are still fairly common in some of the mountainous districts in the interior of the Colony, and range as far north as Somaliland.

The Rhebok. Genus Pelea. [Case 56.] The pale grey medium-sized African Antelope known to the Boers as the Rhebok, or Vaal Rhebok (*Pelea capreolus*, **1167**), which is the only member of its genus, forms in some respects a connecting link between the Neotragine and Cervicaprine Antelopes. With the former it

Fig. 26.

Head of the Reedbuck
(*Cervicapra arundinum*).

Fig. 27

Head of the Lichi Kob
(*Cobus leche*).

(From specimens in the Museum.)

agrees in its comparatively small, straight, and upright horns, whereas in point of size and in several structural features it comes nearer to the latter. In the Rhebok the male only is furnished with horns; and there is no gland below the eye, although there are small lateral hoofs to the feet. Rhebok inhabit the hilly districts of South and South-East Africa, and much resemble Chamois in their general habits. They are usually found in parties numbering from six to twelve; but are now much less abundant than formerly.

Reedbucks. Genus Cervicapra. [West Corridor Cases II & III.] The South African Reedbuck or Reitbok, *Cervicapra arundinum* (**1214**, fig. 26), is the typical representative of the Cervicaprine section of Antelopes, or *Cervicaprinæ*, which includes medium-sized, or large species, with naked muzzles, and narrow, goat-like upper molar teeth. On the face the glands below the eyes are either rudimentary or wanting, but the skull has frequently unossified spaces in this position, as well as pits on the forehead, and there may be glandular patches below the ears. From the other members of the group, Reedbucks, of which there are several species, are distinguished by their comparatively small and forwardly-curved horns, and the rather short and very bushy tail. They have also a bare glandular patch below the ear. The true Reedbuck, which ranges to the Bahr-el-Ghazal, generally associates in pairs, and was formerly abundant on open, grassy, or reedy valleys traversed by streams. Although never found far away from water, these Antelopes keep to dry ground when hunted, and do not seek protection by venturing into boggy localities.

The Waterbucks and Kobs. Genus Cobus. [Cases III, XIII, & XIV.] These Antelopes, the largest members of the Cervicaprine section, are water-loving animals, associating in small herds. Their long and sublyrate horns are ridged nearly throughout their length, and the tail is rather long, and tufted at the tip. Among the larger species are the Common Waterbuck, *C. ellipsiprymnus* (**1218**), of South Africa, distinguished by the white elliptical ring on the rump, the Sing-sing Waterbuck, *C. unctuosus*, of West Africa, and the closely allied Defassa Waterbuck, *C. defassa* (**1219**, fig. 28), of East Africa and Abyssinia. The smaller forms include Mrs. Gray's Kob, *C. maria* (**1220**, fig. 30), the nearly related White-eared Kob, *C. leucotis* (**1221**), of the White Nile, old males of both of which

are blackish-brown, Vaughan's Kob, *C. vaughani* (**1222**), of the Southern Bahr-el-Ghazal, the West African Buffon's Kob, *C. cob* (**1223**), the Uganda Kob, *C. thomasi* (**1224**), the Puku Kob, *C. vardoni* (**1225**), distinguished by the absence of black on the legs, the Lichi or Lechwe, *C. leche* (**1226**, fig. 27), of South Central Africa, and the Black Lichi, *C. smithemani* (**1227**), of the Lake Mweru district. Both the latter have the hinder surface of the pasterns bare. Waterbuck are found in herds of twenty or more; in some districts they frequent steep stony hills seldom more than a mile from a river, to which they flee when pursued, but they often dwell among reeds on river-banks. The Lichi is a swamp-dwelling species, frequently standing up to its neck in water; even when deeply immersed, it never swims, but progresses by leaps.

The Duiker Antelopes. Genus Cephalophus. Together with the Indian Four-horned Antelope (*Tetraceros*), the African Duikers, as typified by the Cape Duiker-Bok, *Cephalophus grimmi* (**1174**), constitute a group of small or medium-sized Antelopes (*Cephalophinæ*) presenting the following characteristics.

[Lower Mammal Gallery. Case 57.]

They have the muzzle naked; large, more or less elongated, glandular openings below the eye; the tail of medium length; lateral hoofs present; but no tufts of hair on the knees. The horns are short and straight; and the upper molar teeth are broad and low-crowned. Duikers have a single pair of horns, which are generally present in both sexes, although smaller in the females than in the males, and are inclined backwards. The crown of the head bears a tuft of long hairs between the horns; and the openings of the gland below each eye form a long naked line on the side of the face above the muzzle. They attain their maximum development in West Africa, where some of the largest species occur. The typical South African species derives its name from the rapidity with which it dives into covert when disturbed. Most of the species go about in pairs. The smallest of all is the South African Blue Duiker, *C. monticola* (**1175**), and the largest the West African *C. sylvicultor* (**1176**), which is of the size of a small Donkey; next to this being the W. African *C. jentinki* (**1177**). Many of the smaller kinds, such as *C. abyssinicus* (**1178**), the banded *C. doriæ* (**1179**) of West Africa, *C. dorsalis* (**1180**), *C. leucogaster* (**1181**), *C. natalensis* (**1182**), and *C. rufilatus* (**1184**), are exhibited.

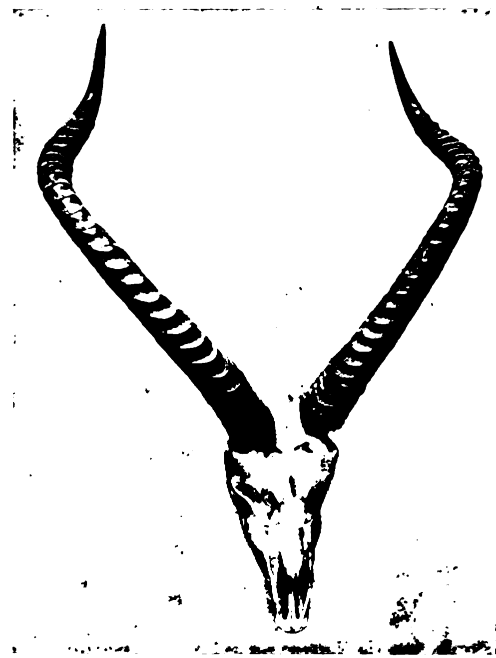
Fig. 28.

Skull and Horns of the Defassa Waterbuck (*Cobus defassa*).

Fig. 29.

Skull and Horns of Jackson's Hartebeest (*Bubalis jacksoni*).

Fig. 30.



Skull and Horns of Mrs. Gray's Kob (*Cobus maria*).

(From specimens in the Museum.)

To face page 45.

Fig. 31.

Head of Coke's Hartebeest
(*Bubalis cokei*).

Fig. 32.

Head of Tiang Hartebeest
(*Damaliscus tiang*).

The Four-horned Antelope. Genus Tetraceros. The one representative of this genus, *Tetraceros quadricornis* (**1187**, fig. 44), differs from the Duikers by the general presence of two pairs of horns in the male, and by the openings of the glands below the eyes forming a deep slit on each side of the muzzle. The females are without horns. The Four-horned Antelope, or Chousingha, as it is called in India, is generally found in pairs, and never associates in herds. Its favourite haunts are undulating or hilly districts, covered with thin forest or bush; but it avoids dense jungle. As it drinks daily, it never wanders far from the neighbourhood of water. Both when walking and running, it moves with a peculiar jerky action. This Antelope is somewhat locally distributed in India.

The Hartebeest & Bontebok Group. Genera Bubalis & Damaliscus. Together with the Gnus, or Wildebeests (*Connochætes*), the Hartebeests (*Bubalis*) and their allies the Bontebok and Blesbok (*Damaliscus*) form a group, or subfamily (*Bubalinæ*) of large-sized Antelopes presenting the following characteristics. The muzzle is naked, a small gland is present below each eye, the nostrils are large, the tail is long and tufted, and the lateral hoofs are relatively large. Horns of considerable size are present in both sexes, those of the female being rather more slender than those of the male; and the upper molar teeth are very tall and narrow. The true Hartebeests are distinguished from the other members by their abnormally long faces, and doubly-curved horns (fig. 29). On the other hand, in *Damaliscus* the face is shorter and the horns are more simply curved. Species of *Bubalis* range throughout Africa and Southern Arabia, whereas *Damaliscus* is restricted to Africa south of the Sahara. Hartebeests frequent open country, and many of them are very swift. Blesboks and Bonteboks were formerly found in herds of enormous size. A very large series of specimens of these Antelopes is exhibited; among those in the first-named genus being the Cape Hartebeest, *Bubalis caama* (**1246**), represented by a male presented by Sir Andrew Smith in 1842, the allied *B. jacksoni* (**1247**, fig. 29) of East Africa, Coke's Hartebeest, *B. cokei* (**1243**, fig. 31), the Tora Hartebeest, *B. tora* (**1244**), of East Africa, and its ally the Sig, or Swayne's Hartebeest, *B. swaynei* (**1242**), of Somaliland, and Lichtenstein's Hartebeest, *B. lichtensteini* (**1240**). In the second group are shown the Bastard Hartebeest, or Sassaby, *Damaliscus* [West Corridor. Cases I, II, XV, XVI, XVII.]

lunatus (**1238**), of South Africa, the East African Hunter's Hartebeest, *D. hunteri* (**1231**), the East African Topi, *D. jimela* (**1233**), and Tiang, *D. tiang* (**1232**, fig. 32), and the South African Blesbok, *D. albifrons* (**1234**), and Bontebok, *D. pygargus* (**1235**), of which a beautiful group, presented by Mr. F. C. Selous, is exhibited.

The Gnus. Genus Connochætes.

[East Corridor. Cases XVIII, XIX, & XX.]

The Gnus, or Wildebeests as they are called by the Cape Dutch, are distinguished, among other features, from the Hartebeests by the downwardly curving, smooth horns, and the very broad muzzle, which is fringed with long bristles, and has the apertures of the nostrils widely separated from one another. In young animals the horns are straight and upright; but in very old bulls they almost join one another at the base. The upright mane, and the thickly-haired long tail are also distinctive features. Gnus inhabit Central, East, and South Africa, and frequent open country in the neighbourhood of water. They possess great speed and endurance; and are remarkable for their habit of indulging in strange gambols and antics when a waggon or horseman approaches their feeding-grounds. The typical or true Gnu of the Hottentots is the South African White-tailed species, *Connochætes gnu* (**1251**, fig. 32, A), now nearly extinct, of which a male presented by Mr. F. C. Selous, and a female and calf, the gift of Mr. Rudd, are exhibited. The second species is the Brindled Gnu, *C. taurinus* (**1252**), of which there are several local races.

The Pronghorn Antelope. Family Antilocapridæ.

[Lower Mammal Gallery. Cases 56 & 57.]

The Pronghorn Antelope, or Prongbuck (*Antilocapra americana*, **1253**, fig. 33), is the sole representative of a family closely allied to the *Bovidæ*, but distinguished by the circumstance that the sheaths of the horns of the males are branched and annually shed, instead of being simple and retained permanently. As a rule, the females are hornless; but when horns are present these are simple and much smaller than those of the bucks. Prongbucks are social animals; individuals of all ages and of both sexes congregating in large herds from September to February. They are the swiftest of North American Ungulates, although their endurance is not great. They differ from most Antelopes in being unable to leap. When running, the hairs of the white patch on the buttocks are erected and expanded so as to form a large chrysanthemum-like patch which forms a guide to the members of the herd in flight.

THE WHITE-TAILED GNU (*Connochætes gnu*) AND ITS SKULL.

(From specimens in the Museum.)

[To face page 46.

FIG. 33.

The Pronghorn Antelope or Prongbuck (*Antilocapra americana*).

Giraffes. Family Giraffidæ. The Giraffes and the Okapi of Africa are the sole living representatives of a family of Ruminants (*Giraffidæ*) distinguished by the double-lobed crowns of the outermost of the four pairs of lower front teeth (fig. 38, A), corresponding to the canines of carnivorous mammals. Their nearest affinities are with the Deer. Giraffes (*Giraffa*)—the tallest of all mammals—have a pair of conical horns covered with skin on the crown of the head, a shorter horn in the middle of the forehead, and in some cases a pair of rudimentary horns at the hinder extremity of the skull. The young have tufts of hair in place of the horns, and a dark patch of hair where the middle horn subsequently grows. Apart from the very distinct Somali Giraffe (*Giraffa reticulata*, **1254**, fig. 35, A), characterised by its liver-red colour marked with a very coarse network of fine lines, there are numerous local forms of the ordinary Giraffe (*Giraffa camelopardalis*, **1255**). The northern races, such as the Nubian *G. c. typica* and the Kordofan *G. c. antiquorum*, are characterised by the large frontal horn [East Corridor. Cases XXI to XXIII.]

of the bulls, the white legs, the network type of coloration, and the pale tint. The latter feature is specially developed in the Nigerian *G. c. peralta,* which is also of the northern type. The

FIG. 34.

Head and neck of male Baringo Giraffe (*Giraffa camelopardalis rothschildi*) showing the five horns.

Baringo *G. c. rothschildi* (fig. 34) also has a large frontal horn and white legs, but the spots in the bulls are very dark, and those of the females jagged. In the Kilimanjaro *G. c. tippelskirchi* the frontal horn is often developed in the bulls, but the legs are frequently spotted to the fetlocks. Further south the frontal horn tends to disappear more or less completely, as in the Angola *G. c. angolensis,* the Transvaal *G. c. wardi,* and the Cape

FIG. 35.

A

B

A—HEAD AND NECK OF SOMALI GIRAFFE (*Giraffa reticulata*).

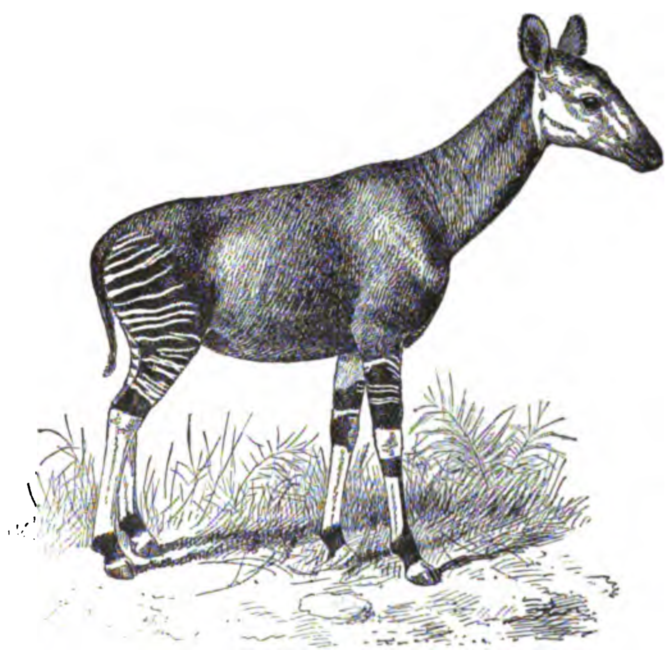
B—HEAD AND NECK OF CAPE GIRAFFE (*Giraffa camelopardalis capensis*).

(From specimens in the Museum.)

[To face page 48.

G. c. capensis (fig. 35, B), while the legs are fully spotted, and the colour-pattern on the body (especially on the last-named) is more of a blotched type, that is to say, consists of dark blotches on a fawn-ground, instead of a network of light lines on the ground. The Museum is indebted to the Duke of Bedford, the Hon. Walter Rothschild, Sir Harry Johnston, Major Powell-Cotton, Captain Gosling, Mr. Victor Buxton, and Mr. Rowland Ward for most of the exhibited specimens of Giraffes. The coloration of Giraffes harmonises so well with their surroundings that at a little distance these animals are invisible. Giraffes lived during the Tertiary period in India Persia, China, and Greece.

FIG. 36.

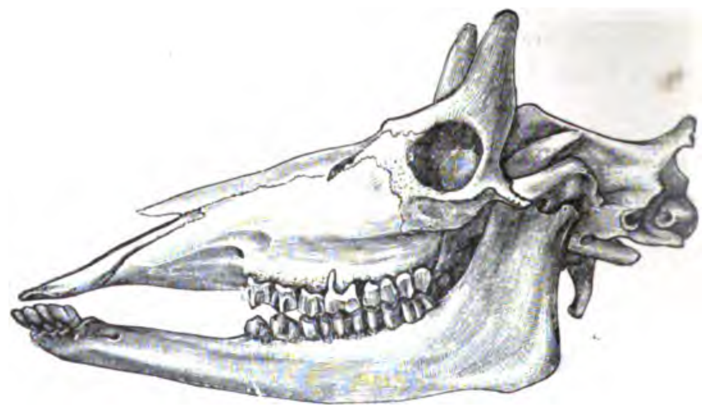


A Female Okapi (*Okapia johnstoni*).

The Okapi. Genus Okapia. The Okapi (*Okapia johnstoni*, **1266**, fig. 36) represents a genus in which the male has one pair of skin-covered horns with bare antler-like tips, while the female is hornless. The neck and limbs are shorter than in the Giraffes, and the type of coloration is different. These animals [East Corridor. Case XXI.]

are found in the depths of the Semliki, or Ituri, forest and its northward extension. Their nearest ally is the extinct *Samotherium* (**1257**), of the Tertiary rocks of Samos and Greece (fig. 37), the males of which are also furnished with a pair of simple horns. On the other hand, in the males of the extinct Indian *Sivatherium* (**1258**), *Bramatherium*, and *Hydaspitherium* (**1259**) the horns are branched; *Sivatherium* having in addition a pair of

Fig. 37.



Side View of the Skull of *Samotherium boissieri*, an extinct Ruminant from the Pliocene of Samos, nearly allied to the Okapi.

small simple horns low down on the forehead. Casts of the skulls of two of these gigantic Ruminants are exhibited in the East Corridor, alongside the Giraffe-case. *Helladotherium*, of the Tertiary of Greece, seems to have been hornless. The Okapi is represented in the Corridor by the two strips of skin sent home by Sir Harry Johnston, on the evidence of which the species "*Equus johnstoni*" was named, as well as by the complete skin of a female forwarded by the same gentleman from the Semliki Forest (fig. 36). The cast of a male skull is also shown.

[Lower Mammal Gallery.] **The Deer Tribe. Family Cervidæ.** The Deer or *Cervidæ* are distinguished from the other members of the Pecora (see page 13) by the appendages on the head, when present, taking the form of antlers; the nature of which is fully explained on page 2. Except in the Reindeer, these are present only in the males, and are always periodically shed. When antlers are wanting, the upper canines of the males are always long and tusk-like, as in the Musk-

Fig. 38.

Lower Front Teeth of Giraffe (A) and Elk (B), to show the difference in the form of the canine.

Fig. 39.

Antlers of the Eastern Red Deer (*Cervus elaphus maral*).

(From specimens in the Museum.)

[*To face page* 50.

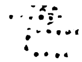


Fig. 40.

Head of Woodland Caribou or Reindeer
(*Rangifer tarandus caribou*).

Fig. 41.

Head of the Alaskan Elk or Moose
(*Alces machlis gigas*).

Deer and Chinese Water-Deer; while in all cases the lower canines have simple crowns (fig. 38), and are thus unlike those of the *Giraffidæ*. Deer are mostly forest animals, and are distributed over all the world (exclusive of Australasia), with the remarkable exception of Africa south of the tropic of Cancer and Madagascar.

The Reindeer, or Caribou. Genus Rangifer. The Reindeer, or Caribou, *Rangifer tarandus* (**1260**), inclusive of its many local phases, forms a genus by itself, readily distinguished from all other Deer by the peculiar form of the antlers (fig. 40), and their presence in both sexes. Frequently—and more especially in American examples—one brow-tine of the antlers is much more developed than the other. In the feet the lateral pair of hoofs is unusually large, and the cleft between the main pair very deep; thus allowing the hoofs to spread out widely, and so to afford a firmer support on the yielding snow. In Scandinavia the Reindeer has long been domesticated; and not only serves the natives as a beast of burden and draught, but likewise supplies them with clothing, milk, and meat. Harnessed to a sleigh, it will draw a load of 300 lbs. a distance of 100 miles per day over the frozen snow. In summer the chief food of the Lapland Reindeer consists of a peculiar kind of moss and certain lichens which the animals search for by scraping away the snow with their feet. The wild Reindeer is a considerably larger animal than the domesticated breed. Young Reindeer are not spotted. The Scandinavian, or typical, Reindeer is represented by a male and female presented by Sir William and Mr. C. Ingram, and by a male of Osborn's Caribou (*R. tarandus osborni*) from the Yukon, and of the Newfoundland *R. t. terræ-novæ* presented by Mr. F. C. Selous, as well as by other specimens.

[Lower Mammal Gallery. Cases B & 58.]

The Elk, or Moose. Genus Alces. In addition to being the largest of living Deer, Elk, or Moose, *Alces machlis*, or *A. alces* (**1261**), are distinguished from other members of the *Cervidæ* by the form of the antlers of the males (fig. 41). These arise as cylindrical beams projecting on each side at right angles to the middle line of the skull, which after a short distance divide in a fork-like manner. The lower prong of this fork may be either simple, or divided into two or three tines, with some flattening. In the East Siberian *A. m. bedfordiæ* (**1262**), as well as in some Scandinavian Elk, the posterior division of the main fork divides into three tines,

[Cases A & 60.]

with no distinct flattening. In the typical form of the Scandinavian or Common Elk (*A. machlis*), on the other hand, this branch expands into a broad palmation, with one large tine at the base, and a number of smaller snags on the free border. The palmation appears to be more marked in the North American race (*A. machlis americanus*) than in the typical Scandinavian Elk. The largest of all is the Alaskan race (*A. m. gigas*, **1262 A**), which is said to stand seven feet in height, with a span of six feet across the antlers. A specimen presented by the Hon. W. Rothschild is shown. The great length of the legs gives an ungainly appearance to Elk. The muzzle is long and fleshy, with a triangular or T-shaped naked patch below the nostrils; and the males have a sac, known as the bell, hanging from the throat. From the shortness of their necks, Elk are unable to graze when standing on level ground; their food consists of young shoots and leaves of willow and birch and various water-plants. In North America during the winter one male and several females form a "Mooseyard" in the forest, which they keep open by trampling the snow. Although generally timid, the males become very bold during the breeding-season, when the females utter a loud call; and at such times they fight both with their antlers and their hoofs. The usual pace is a shambling trot, but when pressed Elk break into a gallop. The female gives birth to one or two young at a time, which are not spotted.

Typical Deer. Genus Cervus.

[Lower Mammal Gallery. Cases 61, 61*, 62, C, D, E.]

In the typical Deer of the genus *Cervus*, in its wider sense, the antlers of the bucks are large and arise at an acute angle from the forehead, while they never divide in a regular forked manner. Very generally they are rounded, or slightly flattened, throughout their length, but in the Fallow Deer they are expanded and palmate. The majority of the species are confined to the Old World; the North American Wapiti being the only one found in the New World. In habits, the Deer of this genus are gregarious animals during the breeding-season, a herd of does and young bucks being headed by one old stag, who has obtained the leadership by driving off his rivals. Usually one fawn is produced at a birth, and this is carefully concealed by the hind in dense covert. All Deer have very regular times of feeding.

The collection of Deer of this and certain other genera has been greatly enriched by specimens presented by the Duke of Bedford.

Red Deer Group.

Cervus elaphus, &c.

[Cases 62 and D.]

In the typical group of the genus *Cervus* are included Deer of large size from Europe, North Africa, Asia, and North America. The long and branched antlers are nearly cylindrical, usually with at least five tines a side, including a brow and a bez. There is a light area, generally including the tail, on the rump, and the tail itself is short. The young are spotted, but in the adult the colour is mostly uniform, although traces of spotting may remain. The Red Deer of Europe, or rather of Sweden (*C. elaphus*, **1263**), is the typical form, with the most complex antlers; in Eastern Europe and Persia it is represented by the variety *C. elaphus maral* (**1264**, fig. 39), in which the antlers are often less complex, and there is much black on the flanks. Other species are Thorold's Deer (*C. albirostris*, **1265**) of Tibet, the Hangul (*C. cashmirianus*, **1266**) of Kashmir, the Yarkand Stag (*C. yarcandensis*, **1267**), and the Shou (*C. affinis*, **1268**) of the Chumbi Valley and Bhutan, the latter characterised by the forward curvature of the five-tined antlers. Wapiti form a sub-group, characterised by the great size of the fourth tine of the autlers, and the circumstance that all the tines above this are in the same fore-and-aft plane, as well by the extreme shortness of the tail, the large size of the rump-patch, and the dark under-parts. The typical Wapiti (*C. canadensis*, **1269**) inhabits Eastern North America, and is represented by a variety (*C. canadensis occidentalis*, **1270**) on the west side of the continent. In Central Asia the group is represented by the Thian Shan Wapiti (*C. songaricus*, **1271**) of the Thian Shan and Western Altai, the Siberian Wapiti (*C. asiaticus*, **1272**), the Manchurian Wapiti (*C. xanthopygus*, **1273**), in which the antlers depart somewhat from the typical Wapiti type, and the Turkestan Wapiti (*C. bactrianus*, **1274**), all of which may be regarded as local races of *C. canadensis*.

Sika Deer. Subgenus Pseudaxis.

[Case E.]

The Deer of the subgenus *Pseudaxis* are all of small or medium size, and inhabit Eastern Asia. Their antlers have only four tines (the bez-tine of the Red Deer group being wanting), the posterior of which is much smaller than the one in front of it. The coat is always spotted with white in summer, but in some species the spots disappear in winter, while in others they persist. The tail is longer than in the Red Deer group, and the light disc on the buttocks pure white, bordered

above and on the sides with black. The group includes the Japanese Deer (*C. sika*, **1275**) and its larger variety the Manchurian Deer (*C. sika manchuricus*, **1276**); the still larger Pekin Deer (*C. hortulorum*, **1277**); and the Formosan Deer (*C. taëvanus*, **1278**), which is not larger than the Japanese species but retains, in accordance with its tropical habitat, the spots throughout the year. A specimen of a race of *C. sika* (**1276**) inhabiting the Liu-Kiu Islands is shown. The hairs of the white rump-patch are expanded under the influence of excitement to form a large white rosette. Most of the specimens were presented by the Duke of Bedford.

Fallow-Deer. Subgenus Dama.

[Cases C, and 60.]

The European Fallow-Deer (*Cervus dama*, **1279**) and the Persian Fallow-Deer (*Cervus mesopotamicus*, **1280**) form a group or subgenus (*Dama*) of the genus *Cervus*, readily characterised by the spotted summer coat and the flattened and expanded (palmated) antlers of the bucks. Although the common species is now extensively kept in English parks, it appears to have been originally introduced from the countries bordering the Mediterranean, where it is still found locally in a wild state. The spots are present only in the summer coat, as is the case in all Deer of temperate climates, in which the spotting is to accord with the speckled shade thrown by trees when in leaf. In tropical spotted Deer, on the other hand, the spots are permanent. There is a park-breed of Fallow-Deer which has a uniform and very dark-coloured coat at all seasons. The Persian Fallow-Deer, which inhabits the mountains of Luristan, has antlers of a different type (fig. 42), and is also distinguished by certain details in colour.

Extinct Irish Deer.

The extinct Irish Deer, *Cervus giganteus* (**1281**), although commonly termed the Irish Elk, is a member of the genus *Cervus*, as is shown by the antlers of the males, which rise at an oblique angle to the middle line of the forehead, instead of at right angles to the same, as in the Elk. By many naturalists it is believed to be allied to the Fallow-Deer, with which it is connected by an extinct species from the superficial deposits of Germany, known as *Cervus ruffi*, in which the antlers have a more upright direction. Although the best-preserved remains are obtained from Ireland, this splendid species is by no means confined to that island, but also occurs in England, as well as a large part of the

Fig. 42.

Head of Persian Fallow-Deer
(*Cervus* [*Dama*] *mesopotamicus*).

Fig. 43.

Head of the Thamin, or Eld's Deer
(*Cervus* [*Rucervus*] *eldi*).

(From specimens in the Museum.)

[*To face page 54.*

Continent. In Ireland the skeletons are found in a freshwater shell-marl situated at the bottom of the peat-bogs, and not in the peat itself.

The Sambar Group of Deer. Subgenus Rusa. In this Indo-Malay group are included the Sambar (*Cervus unicolor*, **1282**) of India and Burma, with its numerous Malay varieties, several closely allied smaller forms from the Malay and Philippine Islands, and the Indian Chital. The antlers, which are frequently very rugose on the surface, are of a simpler type than those of the Red Deer group. They have a single brow-tine, above which the beam rises nearly straight for some distance, to terminate usually in a simple fork. In all, the neck is more or less maned, and the tail of moderate length. The coat may be spotted in summer. The Sambar is peculiar among the genus in having the young generally without spots; it is a massively-built species, standing from 48 to 50 inches in height, and most abundant in hilly districts. The Malay Sambar, *C. unicolor equinus* (**1283**), has more white on the legs and smaller antlers. The smaller *C. swinhoei* (**1284**) of Formosa, and *C. philippinus* (**1285**) and *C. nigricans* (**1286**) from the Philippines, are closely allied; but the Philippine *C. alfredi* (**1287**) is black with white spots. The Chital or Indian Spotted Deer, *C. axis* (**1288**), is also characterised by the chestnut coat being spotted at all ages and seasons; the antlers being of the Rusa type, and the tail rather long, while there is no distinct mane on the neck. The Spotted Deer—which is perhaps the most beautiful member of the family to which it belongs—is one of the most characteristic of Indian Mammals; its especial habitat being amongst bushes and trees in the neighbourhood of water, and in bamboo-jungle. It is found both in hilly ground, and on the plains; but never wanders far from its drinking places. The true Rusa of Java, *C. hippelaphus* (**1289**), is a smaller and longer-haired Deer than the true Sambar, from which it also differs by its more rufous (in place of blackish) colour, and by the shape of the antlers. [Cases 60 & 61.]

The Hog-Deer Group. Subgenus Hyelaphus. The Indian Hog-Deer, *Cervus* [*Hyelaphus*] *porcinus* (**1290**), represents a group of small species nearly allied to the last, but distinguished by certain differences in the under surface of the skull. The Bavian Deer, *C. kuhli* (**1291**), of the Bavian Islands, near Java, is an allied species. [Cases 60 & 61.]

The Barasingha Group. Subgenus Rucervus. A third Indo-Malay group of the genus *Cervus* is represented by the Burmese Thamin (*C. eldi*, **1292**, fig. 43), the Indian

[Cases 61 & 62.] Barasingha or Swamp-Deer (*C. duvauceli*, **1293**), and *C. schomburgki* (**1294**) of Siam. Compared with the Rusa group, these Deer have the beam of the antlers more flattened and more curved, while the large brow-tine arises at an obtuse instead of an acute angle, and the beam divides into two branches, at least one of which is more or less subdivided. In all the three species the tail is short, and the neck maned. The Thamin inhabits swamps and grassy plains, where it associates in herds of from ten to fifty or more individuals. The colour of these Deer is reddish or brownish, without distinct spots; and the gland-tufts on the hind-limbs are but little developed, or absent.

The Muntjacs. Genus Cervulus or Muntjacus. The Muntjacs, as they are called in India, form a group of small Deer confined to China and the Indo-Malay countries. From the genus *Cervus*

[Case 61.] they are readily distinguished by the long pedicles supporting the short antlers of the bucks (fig. 45); these pedicles converge below, and are continued on the sides of the forehead as rib-like ridges. Hence the name of Rib-faced Deer, which is frequently applied to the Muntjacs. The males have long, scimitar-like upper tusks. Muntjacs are solitary creatures, frequenting hilly, forest-clad ground, where they pass most of their time in thick covert, only coming out to graze in the early morning and about sunset. They carry the head and neck low; and in running have an ungainly and somewhat Sheep-like action. In penetrating thick covert at speed, they are unrivalled. The name of Barking-Deer, which is frequently applied to the Indian species, is taken from its peculiar alarm-cry, which is somewhat like the bark of a fox. Specimens of several species such as the Indian *C. muntjac* (**1295**), and the Chinese *C. lachrymans* (**1296**), are exhibited, these being red in colour. Other species, like *C. crinifrons* (**1297**), are however purplish grey in colour, like the members of the next genus.

The Tufted Deer. Genus Elaphodus. The Tufted Deer from China and Tibet, such as *Elaphodus michianus* (**1298**) and *E. cephalophus* (**1299**), comprise a few small species nearly allied to the Muntjacs, from which they may be distinguished by the pedicles supporting the very minute antlers of the males

Skull of the Four-horned Antelope
(*Tetraceros quadricornis*).

Skull of the Muntjac
(*Cervulus muntjac*).

(From specimens in the Museum.)

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converging above, and not being continued as ridges in front of the eyes. There are also marked differences in the form of the skull. These Deer derive their name from the tuft of long hairs crowning the head,—a character possessed also by some of the Muntjacs. In the males the upper tusks are very large, and in both sexes the hair is remarkably coarse. The Tufted Deer probably resemble the Muntjacs in habits. [Case 61.]

The Chinese Water-Deer. Genus Hydropotes or Hydrelaphus. The Chinese Water-Deer (*H. inermis*, **1300**), the sole well-defined representative of its genus, differs from typical Deer and Muntjacs in the structure of the bones of the feet; and in this respect agrees with Reindeer, Elk, Roedeer, and the American Deer. In the skeleton of the fore-foot (as shown in the mounted specimen) only the lower ends of the lateral metacarpal bones (metacarpals ii and v) are retained, whereas in *Cervulus*, *Elaphodus*, and *Cervus* the upper extremities of these bones remain. From all members of the family except the Musk-Deer, the Water-Deer is distinguished by the absence of antlers in both sexes; but the males are furnished with large scimitar-like tusks (fig. 46). The species differs from all other Deer in producing as many as five or six young at birth. These Deer are found in number among the reeds on the banks of the river Yang-tsi-kiang. [Case 58.]

The Roedeer. Genus Capreolus. The Roebuck, *Capreolus vulgaris*, or *Capreolus capreolus* (**1301**), typifies a group of small Deer distinguished by the characters of the antlers of the bucks; which are relatively short, rough, and approximated at the base, and have no brow-tine, but divide at some distance from the head into two branches, the hinder of which usually forks again. There are no tusks in the upper jaw, and the tail is rudimentary. Roedeer generally associate in pairs, and are found chiefly in or near woods. Specimens of the Roebuck in its red summer and olive winter dress are exhibited in the British Saloon at the end of the Bird Gallery. In the Mammal Gallery are also shown examples of the large Siberian Roe, *C. pygargus* (**1302**), and the Manchurian Roe, *C. manchuricus* (**1303**). [Case 61.]

Père David's Deer. Genus Elaphurus. In the absence of a brow-tine to the antlers and the simple fork formed by their first division, Père David's Deer, *Elaphurus davidianus* (**1304**), the single representative of its genus, differs from [Case 59.]

Cervus and resembles the American Deer, although distinguished from the latter by the lateral metacarpal bones being represented by the upper instead of the lower ends. The posterior branch of the first fork of the antlers forms a long straight tine directed backwards, but the front branch is again forked. In gait and general appearance this species is very different from all other Old World Deer. It is known in Europe from specimens kept in the Imperial Park, Pekin; its true habitat being unknown. The species is represented in the collection by the mounted skin of a stag and the head of a hind; both presented by the Duke of Bedford.

American Deer. Genus Dorcelaphus, or Odocoileus, &c.

[Cases 58 & 59.] All the groups of Deer peculiar to America resemble the Roebuck in the structure of the bones of the fore-feet, and are characterised by the form of their antlers, which have no representative of the brow-tine of *Cervus*, but may give off an upright snag some distance above the base, after which they are regularly forked. Among the members of the present genus some, like the Mule-Deer, *Dorcelaphus hemionus* (**1305**), have the two tines of this fork again divided regularly, but in the White-tailed Deer, *D. americanus*, or *virginianus* (**1306**) and its immediate relatives, only the first is thus forked. When adult, the coat is uniformly coloured, but in some species the young are spotted. The Black-tailed Deer, *D. columbianus* (**1307**), of British Columbia is an allied species. In the subgenus *Blastoceros*, in which the direction of the hair on part of the back is reversed, the Pampas or Guázuti Deer, *D.* (*B.*) *bezoarticus* (**1308**), has the antlers with points, and the forked hind-tine much more developed than the simple front-tine. The larger and more northern Guazu, or Marsh-Deer, *D.* (*B.*) *dichotomus* (**1309**), which is found in Uruguay and South Brazil, has the antlers heavier and more complex, both prongs of the main fork being strongly developed, and each subdividing. Generally the hind-prong is stouter than the front one. Whereas the Pampas-Deer is an inhabitant of open plains, the Marsh-Deer frequents swamps and lakes, where it wallows in the mud, or enters the water. The Pampas-Deer utters a kind of whistle when alarmed, and the bucks exhale a strong odour.

The Guemal Deer. Genus Xenelaphus, or Hippocamelus.

The two species of Guemal, *Xenelaphus bisulcus* (**1310**) and *X. antisiensis* (**1311**), are medium-sized Deer confined to the Cordillera of the Andes and Patagonia, and characterised by the single fork, of which the

Fig. 46.—Skull of the Chinese Water-Deer (*Hydropotes inermis*).
Fig. 47.—Skull of the Musk-Deer (*Moschus moschiferus*).
Fig. 48.—Skull of a Chevrotain (*Tragulus javanicus*).

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lower prong is the longer, formed by the antlers of the bucks. [Case 58.] There is a tuft of hair on the inner side of the tarsus, but none on the outer surface of the metatarsus. The fawns are uniformly coloured; and the two species are chiefly distinguished by a slight difference in the antlers, and by coloration.

The Brockets. Genus Mazama. The Brockets, of which there are about half a [Case 58.] dozen species, are some of the smallest American Deer. They are confined to Central and South America. The antlers of the bucks are in the form of simple spikes; and in both sexes the hair on the middle line of the face radiates in all directions from two points, one situated on the crown of the head, and the other below the line of the eyes. The fawns are spotted; and upper canine teeth are present in some of the species. Brockets associate in pairs; the does producing a single fawn in December or January. The adults run with considerable speed for a short distance, but can be easily ridden down. The group is represented in the gallery by a mounted specimen of the Central American *M. sartorii* (**1312**) and by a skeleton of the South American *M. rufa* (**1313**).

Pigmy Deer. Genus Pudua. The species of this genus, *Pudua pudu* (**1314**), of the [Case 58.] Chilian Andes, is the smallest of the American Deer, and is nearly allied to the Brockets, from which it differs by a peculiarity in the structure of the ankle-joint. The antlers of the bucks are very small, and the tail is short. The specimen exhibited was presented by the Duke of Bedford.

The Musk-Deer. Genus Moschus. The Musk-Deer or Kustura, *Moschus moschiferus* [Case 58.] (**1316**), of Central Asia, represents by itself a subfamily of Deer (*Moschinæ*), distinguished by several marked anatomical characters from the *Cervinæ*, which includes all the other Deer. Both males and females are without antlers; but the former have long scimitar-like tusks, projecting some distance below the lips (fig. 47). The hair is very coarse and brittle. The musk, from which the animal takes its name, is secreted in a sac-like gland on the under surface of the body of the male. It has a peculiar and very powerful odour, and is largely used in the manufacture of perfumes. In the Himalaya Musk-Deer are found at elevations of from 8,000 to 12,000 feet, in forest or brush-wood.

They are solitary creatures, more than two adults being seldom, if ever, seen together. They repose during the day in a "form," and feed in the morning and evening. In running, they progress by a series of bounds. The large size of the lateral hoofs renders these animals very sure-footed. The young are spotted, and usually but one is produced at a time. The range of the Musk-Deer extends from Kashmir to Siberia and North-Western China; the animal from the last locality has been described as a distinct species, *M. sifanicus*.

[Lower Mammal Gallery. Cases 63, 64.]

The Camel-Group. Section TYLOPODA. Family Camelidæ. The group of Tylopoda, or "Cushion-footed Ungulates," is now represented only by the South American Llamas (*Lama*), and the Old World Camels (*Camelus*), collectively forming the family *Camelidæ*. As a group, they are characterised by the tall crowns and crescentic columns of the molars, and the presence of upper incisor teeth, although only the outer pair of the latter remains in the adult. In the long limbs only the third and fourth toes of the typical series of five are developed; and these bear hoof-like nails in front, while the sole of the foot forms a soft cushion-like pad. In the skeleton of both fore and hind limbs a cannon-bone is formed, but its lower end is divided to terminate in two smooth surfaces for the articulation of the toe-bones. All the members of the group have very long necks; but the head is devoid of either horns or antlers. The stomach is divided into three compartments, of which the first two contain a number of honeycomb-like cells in their walls for the storage of water. In feeding, Camels and Llamas chew the cud, or ruminate, like the true Ruminants.

The Camels. Genus Camelus. The Camels of the Old World comprise two species, only one of which is now found in a truly wild state. They are characterised by their large size, clumsy build, short ears, long tail, and the presence of either one or two humps on the back. The Arabian Camel, *Camelus dromedarius* (**1325**), which has but one hump, is employed as a beast of burden in N. Africa, Arabia, and India, and has been lately introduced into Australia and parts of the United States. The two-humped Bactrian species, *C. bactrianus* (**1326**), has a more northern

distribution, being domesticated throughout a large portion of Turkestan and the neighbouring region, extending as far as the Crimea in the west, and to Lake Baikal and Pekin in the east. Some of the wild Camels found near Yarkand are probably derived from animals that originally escaped from captivity; but others found in the deserts of Central Asia appear to be truly wild. The Bactrian species is the heavier and more clumsily-built of the two, and has shorter legs and thicker hair, and is better adapted for traversing rocky ground. From the large loads they carry, and their capacity for going a long time without water, Camels are most valuable beasts of burden, although their disposition is surly, and their temper uncertain. Fossil species are found in the north of India and Algeria, as well as in Russia and Rumania.

The Llamas. Genus Lama. Under the general title of Llamas may be included not only the South American domesticated animals properly so called, but likewise the wild Vicugna, *Lama vicugna* (**1327**), and the Guanaco, *L. huanacus* (**1328**). They are much smaller and less bulky animals than the Camels, with longer ears, shorter and more bushy tails, and no hump on the back. The wild species associate in large herds; both inhabit the high Andes immediately below the snow-line, but the Guanaco ranges southwards on to the plains of Argentina and Patagonia. They are exceedingly vigilant and shy; and their only means of defence is by spitting. The domesticated kinds are the true Llama, *L. glama* (**1329**), and the Alpaca, *L. alpaca* (**1330**), both of which appear to be descended from the Guanaco. The Alpaca is kept in large flocks, which graze on the open uplands of the Andes of Southern Peru and Northern Bolivia, at elevations of from fourteen to sixteen thousand feet. It is smaller than the Llama, and valued for its wool, of which blankets and ponchos are made. On the other hand, the Llama is employed as a beast of burden. Specimens of the Llama are exhibited in the North Hall, with the other domesticated animals. Remains of extinct Llamas are abundant in the earlier Tertiary deposits of North, but not of South America; the group having immigrated comparatively recently into the latter country. The specimen of the ~~Guanaco~~ was presented by Dr. F. P. Moreno, when Director of the Museum at La Plata. Vicugna

[Case 64.]

[Lower Mammal Gallery. Case 64*.]

The Mouse-Deer or Chevrotains.
Section TRAGULINA.
Family Tragulidæ.

The Mouse-Deer or Chevrotains, *Tragulidæ*, form a small group of Asiatic and African Artiodactyle Ungulates, in some respects intermediate in structure between Pigs, Camels, and Deer, with the latter of which they are often confounded. From the Pigs (Suina) they differ by the absence of upper incisor teeth, and by the crescent-shaped (selenodont) structure of the cusps of the molar teeth. The upper canines of the males are well developed and scimitar-like (fig. 48); but those of the lower jaw form a continuous series with the incisors, which they resemble in shape. Each foot has four complete toes. In the skeleton the fibula, or smaller bone of the leg, is complete; and the two middle metacarpals and metatarsals are in most cases respectively united to form a cannon-bone. The skull carries neither horns nor antlers. Chevrotains ruminate their food like the Pecora, but their stomachs have only three compartments, in place of the four found in the latter. They have somewhat the habits of Hares, skulking in thick grass, from which they run with great speed when driven out. Several species of the true or Asiatic Chevrotains, such as the Indian *Tragulus meminna* (**1331**), are exhibited, as well as one of the African representative of the group, *Dorcatherium aquaticum* (**1334**), a species inhabiting the tropical forest-zone of the West and Central districts.

[Cases 65-67.]

The Pig-like Group.
Section SUINA.

The Hippopotamuses, the Peccaries of America, and the Pigs of the Old World form the most generalised section of existing Artiodactyle Ungulates, known as the Suina. Their molar teeth have tuberculated, or "bunodont," crowns; and the third and fourth metacarpal and metatarsal bones of the feet are either completely separate, or are not fully united to form cannon-bones. Extinct forms serve, however, to connect the Suina more or less closely with the Pecora.

[Cases 66 & 67.]

The Hippopotamuses.
Family Hippopotamidæ.

The Hippopotamuses—both the species of which are confined to Africa, and may be included in the genus *Hippopotamus*—are characterised by their massive form, the wide and squared muzzle, and the broad and short feet, which have four subequal toes,

bearing short, rounded hoofs, and all touching the ground. The large incisor and canine teeth grow continuously; the upper incisors curving outwards, and the lower projecting forwards, while the canines are very large, and those of the upper jaw directed downwards. In the common species, *H. amphibius* (**1340**), which till recently ranged over the greater part of Africa, there are two pairs of incisors in each jaw; but in the much smaller *H. liberiensis* (**1341**), of the West Coast, there is generally only one lower pair, although some specimens (like the one exhibited) have two teeth on one side and one on the other. In certain extinct species (as shown in a lower jaw exhibited) there were, however, three pairs of equal-sized incisors in each jaw.

Although Hippopotamuses are now restricted to Africa, the common species ranged during the Pleistocene period as far north as England, and a smaller kind existed in Madagascar. In the antecedent Pliocene epoch several kinds flourished in India and Burma, where they survived till the Pleistocene. The common species—of which the numbers and range are now greatly reduced—lives in herds of from twenty to forty in the neighbourhood of rivers, where it finds its food, which consists of grass and aquatic plants. It feeds chiefly by night; and in districts where it is much hunted, spends most of the day in the water. There it is thoroughly at home, not only diving and swimming with facility, but walking easily on the river-bed. The Liberian species is stated to be much less aquatic, and more like a Pig in its habits. The splendid mounted specimen of the ordinary Hippopotamus was presented by Mr. Rowland Ward, of Piccadilly.

The Peccaries.
Family Dicotylidæ.

The Peccaries (*Dicotyles* or *Tayassu*) of America differ from the Old World Pigs (*Suidæ*) in that the upper canine teeth are directed downwards and have sharp cutting-edges, in the reduction of the number of hind-toes to three, and in the complex structure of the stomach. Moreover, the upper ends of the metacarpal and metatarsal bones of the feet are respectively united. The total number of teeth is thirty-eight, there being only two pairs of upper incisors, and three pairs of premolars in each jaw. [Case 65.]

Peccaries are inhabitants of forest districts, and produce only two young at a birth, which are not spotted or striped with white.

The Collared Peccary, *D. tajacu* (**1342**), is found singly, in pairs, or in small parties of eight to ten, and is quite harmless; but the larger White-lipped Peccary, *D. labiatus* (**1343**), is generally met with in herds of from fifty to a hundred head, and is of a more savage disposition, its sharp tusks inflicting severe wounds. Both kinds are omnivorous, and do much harm to cultivated lands.

The Pigs. Family Suidæ.

[Lower Mammal Gallery. Cases 65 & 67.]

The Pigs or Swine of the Old World, constituting the family *Suidæ*, are characterised by the possession of a long mobile snout, terminating in an oval, flat, truncated, nearly naked disc, in which the nostrils are placed, and by the upward curvature of the tusks (canines) in the males, or in both sexes. The hoofs of the two middle toes have their adjacent surfaces flattened; while the lateral toes do not touch the ground in walking. The tusks continue to grow throughout life, but the incisor teeth are rooted. The molar teeth have rectangular crowns, the tubercles on which never wear into the distinct trefoils characterising those of the Hippopotamus. The skull is distinguished by its great length, more or less nearly straight profile, and the high, backwardly-inclined occipital crest. Very frequently the young are striped; and there are always many individuals in a litter.

Wild Pigs are omnivorous animals, feeding largely upon roots and tubers, which are turned up from the ground by the mobile snout. Consequently, they do much harm to agriculture, especially when they associate in large herds.

Typical Wild Swine. Genus Sus.

[Case 67.]

The Pigs belonging to the typical genus *Sus* have usually a total of forty-four teeth, their tusks being relatively smaller than in the Wart-Hogs, and being covered in part with enamel throughout their whole length, instead of only at the tip. The last molar in each jaw is relatively wide and of moderate length. As in the Wart-Hogs, the lower tusks wear against the sides of the upper ones. The genus includes three subgeneric groups, often ranked as separate genera. Firstly, *Sus* proper, which comprises the typical Wild Pigs, ranging over the greater part of Asia, and Africa north of the tropics. Secondly, the diminutive Pigmy

Hog (*Porcula*) of the Bhutan and Nepal Terai. Thirdly, the African Bush-Pigs, or River-Hogs (*Potamochœrus*). In the latter the anterior premolars are generally shed in the adult, and the molars are of a somewhat simpler type, while the skull has some strong rough ridges above the root of the upper tusk. In all, the young are striped. Most of the species go about in herds, or "sounders," of considerable size, each headed by an old boar. The lower tusks of the males are terrible weapons of offence, capable of ripping open a horse with one sweep. If the upper tusk be broken, the lower one continues to grow till it forms a circle, as shown by specimens in the North Hall.

Two magnificent specimens of the Wild Boar, *Sus scrofa* (**1344**)—one a complete skin from Russia, presented by Count J. Potocki, the other a head from Amurland, the gift of the Hon. Walter Rothschild—are exhibited in the gallery. A fine example of the Indian Wild Boar, *Sus cristatus* (**1345**)—a species taking its name from the crest of long bristles on the nape of the neck—is also shown. In the North Hall is placed an example of the last-named species bred in Windsor Forest, and presented by H.M. the King; it appears to have developed some of the characteristics of the European species. In the North Hall are also exhibited models, heads, and skulls of various domesticated breeds, the derivatives of the European Wild Boar, with perhaps in some cases a cross of Eastern blood.

In the Mammal Gallery is shown the common Malay Wild Boar, *Sus vittatus* (**1346**), as well as one of the long-snouted *S. barbatus* (**1347**) from Borneo, the gift of Dr. C. Hose.

The African Bush-Pigs are represented by the Red River-Hog, *Sus* [*Potamochœrus*] *porcus* (**1348**) of West Africa, and *S. chœropotamus nyasæ* (**1349**), one of the examples of the latter presented by Sir Harry Johnston.

The Pigmy Hog of North-eastern India, *Sus* [*Porcula*] *salvanius* (**1350**) is represented by a specimen collected by the original describer of the species, Mr. Brian Hodgson, sometime British Resident at the Court of Khatmandu.

Of the great black Forest-Hog, *Hylochœrus meinertzhageni* [Case 65.] (**1351**), of the forest-zone of Equatorial Africa, only a skull is at

present exhibited. This animal is allied to the Wart-Hog, but has the skull less specialised.

The Wart-Hogs.
Genus Phacochœrus.

[Case 65.] The African Wart-Hogs (*Phacochœrus*) take their name from the large wart-like lobes projecting from the sides of the face, but are more particularly distinguished by the character of the dentition. In young animals there is a total of thirty-four teeth, of which one pair (canines) forms huge tusks, while there is one pair of upper, and three of lower incisors. Of cheek-teeth there are six upper, and five lower pairs; the first three upper and the first two lower being premolars, and the remaining three in both jaws molars. In very old animals only the tusks and last molars may remain. The tusks are large in both sexes; and the last molar is a long and complex tooth, formed of a number of closely-packed vertical columns. Unlike those of ordinary Wild Pigs, the young are uniformly coloured. There are two closely allied species or varieties of the genus; namely, the Northern *P. æliani* (**1352**), represented by a skeleton, and the Southern *P. æthiopicus* (**1353**), of which a male and female, presented by Mr. F. C. Selous, are shown. In habits they resemble the majority of the Pig-family, although they frequently take up their abode in the deserted burrows of the Aard-Vark. When driven out from such strongholds, they rush with great ferocity upon the dogs and hunters. They usually associate in pairs or small family-parties.

The Babirusa.
Genus Babirusa.

[Case 65.] The Wild Boar, or Babirusa ("Pig-Deer"), of Celebes, *Babirusa alfurus* (**1354**), alone represents a genus distinguished by the extraordinary development of the tusks of the male. These teeth grow continuously, and are long, slender, curved, and devoid of enamel; those of the upper jaw curving upwards, and piercing the skin without entering the mouth. The number of teeth is thirty-four; there being only two pairs of upper incisors, and two of premolars in each jaw. The skin is very rough and almost entirely devoid of hair. A mounted specimen and several skulls are exhibited.

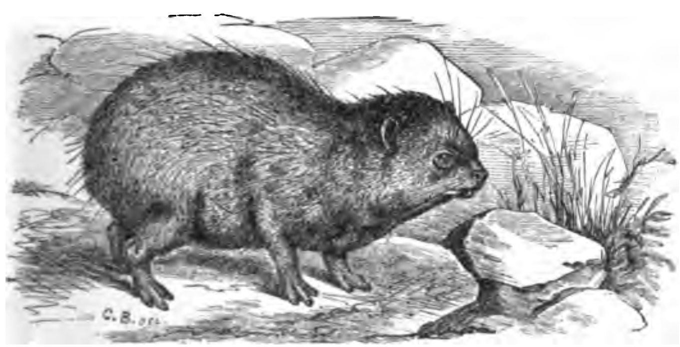
SUBORDER HYRACOIDEA.

[Lower Mammal Gallery. Case 35*.]

The Hyraxes of Syria and Africa form a subordinal group of Ungulates of which the existing representatives have no right to be reckoned as "Great Game" animals, although in past times they were represented in Africa (which apparently formed the original home of the group) by species as large as Tapirs. The molar teeth, and likewise the feet, present certain resemblances to those of Rhinoceroses.

On the Continent they are commonly known as Damans, but in South Africa they are called Klip-Das (Rock-Badger),—a title corrupted by the English colonists into "Dassie."

FIG. 49.



The Syrian Hyrax (*Procavia syriaca.*)

All the species may be included in the family *Procaviidæ,* and the genus *Procavia* (formerly called *Hyrax*). In general appearance they are very similar to Rodents, but their feet are of an Ungulate type; the fore-feet being four-toed, and the hind pair three-toed. With the exception of the inner one on the hind-foot, which has a long, curved claw, the toes are furnished with broad, short, hoof-like nails. The upper jaw has a single pair of long, triangular incisors which grow throughout life; and in the lower jaw there are two pairs of such teeth, which are rooted. There are no canines, and the cheek-teeth are of the general type of those of the Rhinoceroses. A few of the numerous species climb trees, but the majority are terrestrial and social animals, generally living in

rocky or stony places, where they dwell either in holes beneath the rocks, or in the crevices between them. They feed chiefly on leaves and young twigs; and are usually only to be seen abroad in the early morning and in the evening. The Syrian species (fig. 49) is the animal called "Coney" (= Rabbit) in the English version of the Bible. Examples of several species are exhibited in the case (Nos. **983–990**).

Suborder PROBOSCIDEA.

[Central Hall and Fossil Mammal Gallery.]

Since the great majority of the members of this, the last subordinal group of Ungulates are extinct, it has been deemed advisable to exhibit the mounted specimens, skeletons, tusks, and teeth of its two existing representatives—the Asiatic Elephant (*Elephas maximus*) and the African Elephant (*E. africanus*)—in the neighbourhood of or alongside the remains of their fossil cousins and ancestors.

Fig. 50.

Skull of the African Elephant (*Elephas africanus*).

In modern Elephants the feet are short, broad and massive, and unlike those of any other existing Ungulates. They have, for instance, five toes, all encased in a common skin, with a flat truncated sole; externally the only indications of the toes are the broad oval nails, or hoofs, arranged in a semicircle round the front edge of the sole. The teeth comprise a pair of huge tusks, or incisors, in the upper jaw (fig. 50), which grow uninterruptedly throughout life, and large transversely ridged molars (fig. 52), of which only one or two portions of two on each side of each jaw are in use at the same time; six pairs of these teeth being, however,

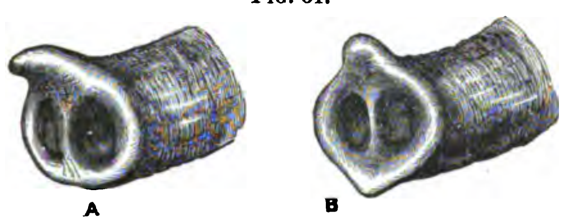
developed during the animal's life in both jaws. The most distinguishing external feature of the group is the extension of the upper lip and nose into the long, flexible and prehensile trunk or proboscis (fig. 51), at the tip of which are situated the nostrils.

The largest of all land Mammals, Elephants are exclusively vegetable-feeders, subsisting chiefly upon leaves and young branches of forest-trees, or upon both these and roots. Both liquid and solid food are conveyed to the mouth by means of the proboscis in the case of adults, although the young suck with their mouths.

For the past history of the Proboscidea the reader may be referred to the specimens in the Geological Department and the Guide devoted to their description.

The Asiatic or Indian Elephant, which ranges from India and Ceylon through Burma and the Malay Peninsula to Sumatra, is characterised by the relative flatness of the forehead, the comparatively small ears, and the regularly tapering and perfectly elastic trunk; the tail has two rows of bristles at the tip and a short distance above; and the trunk has one rather large finger-like process on the front edge of its extremity (fig. 51, A). The

FIG. 51.

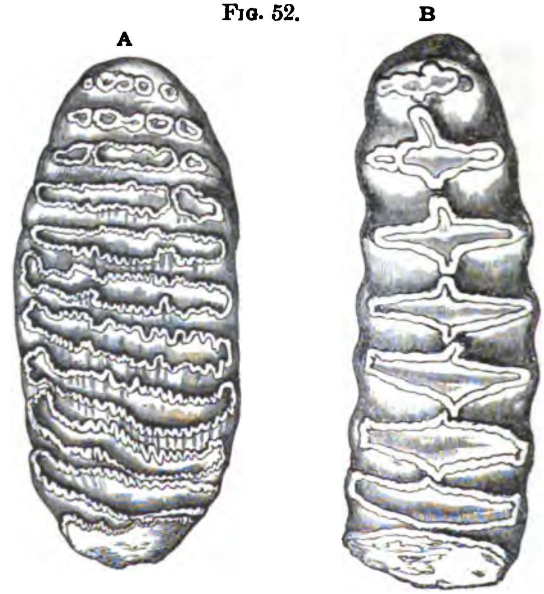


Tip of Trunk of the Asiatic (A) and the African Elephant (B).

hind-foot has four nails, whereas there are generally only three in the African species. Usually the females have very small tusks, which do not project beyond the jaw, and in some cases the same holds good with males, such tuskless males being termed Maknas. In Ceylon the indigenous race seems to have been tuskless. In the Malay countries the species is prone to partial albinism; specimens in which this feature is most developed constituting the sacred "white elephants" of Burma and Siam. The Indian Elephant feeds chiefly on grasses, sugar-cane, and leaves. Being extremely impatient of the sun's rays, in the hot weather it passes the day

in the densest jungle. Elephants usually go about in her[…] numbering from 30 to 50 individuals, but the older bulls freque[…] dwell alone for a time. Others—known as "rogues"—a[…] permanently solitary. Of this species a stuffed specimen [...] placed in the Fossil Mammal Gallery; it belongs to the race [...] which the tusks are not fully developed. When alive, th[...] Elephant was brought from India by H.M. the King when Prin[...] of Wales, and it lived for many years in the Zoological Society[...] Gardens in the Regent's Park. The Mammoth was closely allied [...] the Indian species, from which it differed by the greater curv[...] of the tusks, and the coat of woolly, reddish hair, interspersed wi[...] bristles. Remnants of this woolly covering have been detected [...] the living species; and in new-born calves, as shown by a specim[...] in the Fossil Mammal Gallery, it is strongly developed.

FIG. 52.



An Upper Molar of the Asiatic (A), and of the African Elephant (B).

Among several skulls exhibited, the finest is one belonging t[...] an elephant shot by Mr. G. P. Sanderson, in the Garo Hills, Assam, in 1888. Two tusks bequeathed by Lt.-Colonel G. M. Payne respectively weigh 77 and 73 lbs.

In the African Elephant (*Elephas africanus*) the molar teeth have fewer and wider plates of dentine and enamel, which in the worn condition form lozenge-shaped surfaces (fig. 52, B), with the borders of enamel much less crimped, or frilled, than in the Asiatic species. Externally, the African Elephant is distinguished by its huge ears, the very convex forehead, and the presence of two small finger-like processes on the tip of the trunk (fig. 51, B), while the trunk itself is less regularly tapering and elastic, looking as though composed of a number of distinct segments, comparable to the joints of a telescope. Tusks are generally present in both sexes, and frequently attain very large dimensions. This species often grows to ten feet in height, and may reach eleven or more. It feeds almost entirely on twigs, leaves and roots, throwing down trees for the purpose of obtaining the latter, and also digging for these with its tusks. Although equally fond of water, it is far less impatient of heat than its Indian cousin, and may frequently be seen basking in the sun. Like the latter, this species associates in herds.

The African Elephant formerly inhabited the whole of Africa south of the Sahara, but is now driven back towards the centre of the continent; its fossil remains have also been found in North Africa and Southern Europe. It is more courageous and more ill-tempered than its Indian ally, and therefore more difficult to tame; none of the present African natives have attempted its domestication. Owing to the value of its ivory it is continually hunted; and it is to be feared that the species will eventually become extinct.

The species is represented in the collection by a magnificent mounted male from near Fort Manning, South Nyasaland, or British Central Africa (see Frontispiece*), standing 11 feet 4 inches at the shoulder; and also by a mounted head from Lake Rudolf, presented by Mr. H. S. H. Cavendish. Among several specimens of skulls and tusks, one tusk is remarkable for its huge size, measuring 10 feet 2 inches in length, and $24\frac{1}{4}$ inches in maximum girth, and weighing 228 lbs.

Considerable differences, both as regards external form and the

* In taking this photograph it was found impossible to get the whole animal in focus, so that the head, tusks, and trunk appear abnormally large.

characters of the skull, are noticeable in Elephants from different parts of Africa. The most easily recognised points of distinction are the size and shape of the ears.

I. In the South African Elephant (*Elephas africanus capensis*) the ears are enormous (4 feet 5 inches by 4 feet in a female 8 feet 8 inches high), somewhat square in shape, with rounded corners, and a small, sharply pointed angular lappet in front. The forehead falls away towards the temples, so as to appear highly arched.

II. The West African Elephant (*E. africanus cyclotis*), typically from South Cameruns, also has the ears very large, but of quite different shape, the contour being oval, and the lappet in the form of a half-ellipse. The skin has a mosaic-like appearance, and its colour is a paler grey than in the third race.

III. In the Sudan Elephant (*E. africanus oxyotis*) the ears are considerably smaller, and semicircular in shape, with the front lappet very sharply pointed and angular.

IV. The East African Elephant (*E. africanus knockenhaueri*), typically from German East Africa, has still smaller ears, which are triangular in shape, with the front lappet angulated and pointed. The exhibited specimen (whose ears measure 4 feet 2½ inches by 3 feet 5 inches) appears to come nearest to this race.

In addition to the above, there is a dwarf race of Elephant from the Congo (*E. africanus pumilio*), whose height may not have exceeded 7 feet. The Albert Nyanza Elephant has also been separated as a distinct race, under the name of *E. africanus albertensis*, characterised by certain peculiarities in the form of the skull, which is unusually short and broad.

LIST OF

The Best Specimens of Horns, Antlers, and Tusks in the Collection of the Museum.

[*The length of specimens is measured along the front curve; the girth is the maximum basal circumference; tip to tip measurement is the direct line between the tips.*]

A.—RHINOCEROS HORNS.

	No.		*Length.* in.	*Girth.* in.
Rhinoceros unicornis. Indian Rhinoceros ……… *Transferred from the India Museum*, 1879.	79.11.21.47		13	$18\frac{3}{4}$
Rhinoceros sondaicus. Javan Rhinoceros ……… *Purchased from E. Gerrard*, 1876.	76.3.30.1		$10\frac{5}{8}$	$19\frac{5}{8}$
Rhinoceros sumatrensis. Sumatran Rhinoceros……… *Presented by Mr. Edward Cross*, 1854.	54.12.11.1	(front horn)	$32\frac{1}{8}$	$17\frac{3}{8}$
Rhinoceros bicornis. Common or Black African Rhinoceros .. *Collected by Sir Andrew Smith*, 1838.	38.6.9.101	(front horn)	$21\frac{3}{8}$	22
		(back horn)	19	$21\frac{1}{2}$
Rhinoceros simus. White or Square-mouthed Rhinoceros …. *No history.*	1167 *b*	(front horn)	$56\frac{1}{2}$	$23\frac{1}{2}$

List of Horns, Antlers, and Tusks.

B.—HOLLOW-HORNED RUMINANT HORNS.

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.
Bos ægyptiacus. Ankole Cow .... *Presented by Lt.-Col. C. Delmé-Radcliffe*, 1901.	O. 29	41½	14¾	54
Bos taurus. Cape Trek-Ox .... *Presented by S. African Cold Storage Co.*, 1901.	O. 4	33	12	59¾
Bos indicus. Galla Ox .... *Purchased from H. Salt, Esq.*, 1852.	52.12.15.9	47	15⅝	21⅛
Bos gaurus. Gaur .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.209	25½	18	33
Bos frontalis. Gayal .... *Purchased from E. Gerrard*, 1896.	96.6.20.1	17¼	17	41
Bos sondaicus. Banting .... *Presented by H. B. Low, Esq.*, 1800.	80.5.4.3	21⅜	12¼	13⅛
Bos sondaicus birmanicus. Tsaine or Burmese Banting .... *Presented by R. MacD. Hawker, Esq.*, 1900.	0.9.11.1	27	14½	20¼
Bos (Pöephagus) grunniens. Yak .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.219	38¼	17	19
Bos (Bison) bonasus. European Bison .... *Presented by H.I.M. The Czar of Russia*, 1845.	45.10.13.1	18¼	12⅛	13¾
Bos (Bison) bison. American Bison	[illegible]	[illegible]	[illegible]	[illegible]

Purchased, 1852.

Bos (Bubalus) æquinoctialis. Abyssinian Buffalo *Purchased from Gerrard*, 1874.	74.11.2.3	$31\frac{3}{8}$	Greatest o side widt	$26\frac{7}{8}$	Greatest side widt	$24\frac{3}{8}$
Bos (Bubalus) nanus. Congo Buffalo *Presented by the Royal Society.*	606 *a*	$21\frac{1}{8}$		$12\frac{3}{4}$		$2\frac{1}{4}$
Bos (Bubalus) bubalis. Indian Buffalo *Sir Hans Sloane Collection.*	604 *d*	$77\frac{3}{8}$		$17\frac{1}{8}$		—
Bos (Bubalus) depressicornis. Anoa *Presented by the Zoological Society*, 1858.	58.5.4.5	$12\frac{3}{8}$		6		$6\frac{1}{2}$
Ovis ammon. Siberian Argali *Presented by St. George Littledale, Esq.*, 1896.	96.10.14.1	56		$18\frac{1}{2}$		35
Ovis hodgsoni. Tibetan Argali *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.187	$42\frac{1}{8}$		$16\frac{3}{4}$		$14\frac{1}{4}$
Ovis poli. Marco Polo's Sheep *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.181	66		$15\frac{1}{4}$		44
Ovis littledalei. Littledale's Sheep *Presented by St. George Littledale, Esq.*, 1902.	2.3.9.7	$61\frac{1}{2}$		$19\frac{1}{4}$		$39\frac{1}{4}$
Ovis vignei. Shapo *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.180	29		12		$18\frac{1}{2}$
Ovis vignei blanfordi. Baluchi Urial *Collected by Dr. J. Aitchison*, 1886.	86.10.15.21	$35\frac{1}{2}$		$10\frac{1}{2}$		16
Ovis gmelini. Armenian Wild Sheep *Presented by W. B. Barker, Esq.*, 1854.	54.1.34.1	$40\frac{1}{4}$		$10\frac{1}{2}$		$5\frac{1}{2}$

List of Horns, Antlers, and Tusks.

Hollow-horned Ruminant Horns (*continued*).

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.
Ovis ophion. Cyprian Mouflon *Presented by Gen. Sir R. Biddulph*, 1885.	85.3.2.1	23	7	5¾
Ovis musimon. Corsican Mouflon *Presented by the Zoological Society*, 1853.	53.8.29.19	27	8½	10
Ovis canadensis. Bighorn Sheep *Presented by the Zoological Society*, 1852.	52.9.18.16	40¾	16½	—
Ovis dalli. White Bighorn *Presented by J. T. Studley, Esq.*, 1899.	99.2.24.1	32½	13¼	20½
Ovis stonei. Black Bighorn *Presented by D. T. Hanbury, Esq.*, 1905.	5.11.23.1	36¾	12½	21¼
Ovis lervia. Udad, or Barbary Sheep *Presented by the Hon. John Ward*, 1896.	96.12.15.1	28½	11½	18
Ovis nahura. Bharal, or Blue Sheep *Presented by A. O. Hume, Esq., C.B.*, 1901.	91.8.7.200	28	11	20¼
Capra cylindricornis. Pallas's Ture *By exchange with the Warsaw Museum*, 1879.	79.11.15.1	33⅜	12	19¾
Capra caucasica. West Caucasian Ture *Presented by St. George Littledale, Esq.*, 1892.	92.3.16.1	34¾	11	10
Capra pyrenaica. Spanish Ibex	[illegible]	[illegible]	[illegible]	[illegible]

Capra hircus ægagrus. Wild Goat .... *No history.*	650 g			
Capra hircus blythi. Sind Wild Goat .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.161	44½	8⅝	11
Capra nubiana. Nubian Ibex .... *Presented by J. Burton, Esq.*	651 *b*	46⅛	8	—
Capra vali. Abyssinian Ibex .... *Purchased from Major Powell Cotton*, 1900.	0.6.18.1	43½	11¼	27
Capra ibex. Alpine Ibex .... *No history.*	650 *a*	43	10¼	35½
Capra sibirica. Kuldja Race of Siberian Ibex................ *Presented by St. George Littledale, Esq.*, 1902.	2.3.9.4	50⅝	11¼	35½
Capra falconeri. Markhor .... (single horn) *Transferred from India Museum (Dr. H. Falconer)*, 1879.	782.6	46½	11½	—
Capra falconeri jerdoni. Suleiman Markhor .... (single horn) *Presented by Lt.-Col. Grant.*	79.6.21.1	48½	7¾	—
Hemitragus jemlaicus. Tahr .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.126	13¾	9	11¼
Hemitragus hylocrius. Nilgiri Tahr, or Ibex .... *Presented by E. Partridge, Esq.*	654 *a*	14½	8¾	6½
Ovibos moschatus. Musk-Ox .... *Presented by Dr. J. Rae*, 1853.	53.9.20.1	26¾	12⅜	—
Budorcas taxicolor. Takin .... *Purchased from C. F. Rowe, Esq.*, 1881.	81.6.20.12	22⅜	10⅝	14¾

List of Horns, Antlers, and Tusks.

Hollow-horned Ruminant Horns (*continued*).

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.
Haploceros montanus. Rocky Mountain Goat .... *J. Bate, Esq.*	87.3.24.1	$9\frac{1}{8}$	$5\frac{1}{4}$	6
Nemorhædus sumatrensis. Sumatran Serow .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.97	9	5	2
Nemorhædus bubalinus. Himalayan Serow .... *Presented by R. Lydekker, Esq.*, 1888.	88.3.20.6	$9\frac{3}{4}$	$5\frac{1}{8}$	6
Rupicapra tragus. Chamois .... *Presented by C. G. Danford, Esq.*, 1886.	86.12.27.1	$9\frac{3}{4}$	$3\frac{1}{4}$	$3\frac{7}{8}$
Taurotragus derbianus. Derbian Eland .... *Presented by the Earl of Derby*, 1846.	1648 *a*	$32\frac{1}{2}$	$12\frac{1}{2}$	$29\frac{7}{8}$
Taurotragus oryx. Eland .... *Purchased from F. C. Selous, Esq.*, 1881.	81.10.28.7	$31\frac{1}{2}$	$12\frac{3}{4}$	$12\frac{1}{2}$
Böocercus euryceros. Bongo .... *Presented by the Zoological Society*, 1858.	58.5.4.7	31	11	11
Strepsiceros kudu. Kudu .... *Presented by Sir H. H. Johnston, K.C.B.*, 1893.	93.7.9.25	52	11	$29\frac{3}{4}$
Strepsiceros imberbis. Lesser Kudu .... *Presented by R. MacD. Hawker, Esq.*, 1896.	96.6.9.19	34	$6\frac{3}{4}$	11
Tragelaphus spekei. Situtunga, or Nakong.................. *Purchased from F. C. Selous, Esq.*, 1881.	81.10.28.8	$31\frac{1}{2}$	7	[illegible]

Tragelaphus gratus. West African Sitatunga .... *Purchased from E. Gerrard*, 1882.				
Tragelaphus angasi. Nyala .... *Purchased*, 1850.	50.8.30.1	28	$8\frac{1}{8}$	$10\frac{1}{8}$
Tragelaphus scriptus. Bushbuck .... *Purchased from Morton Green, Esq.*, 1889.	89.2.4.3	17	$7\frac{1}{2}$	$5\frac{1}{2}$
Boselaphus tragocamelus. Nilgai .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.51	$9\frac{1}{4}$	$6\frac{3}{4}$	$4\frac{7}{8}$
Hippotragus niger. Sable Antelope .... *Purchased from F. C. Selous, Esq.*, 1883.	83.7.28.3	43	$9\frac{3}{4}$	$6\frac{1}{2}$
Hippotragus equinus. Roan Antelope .... *Purchased from E. Gerrard.*	636 *h*	24	$8\frac{3}{4}$	8
Oryx gazella. Gemsbuck .... *Purchased from F. C. Selous, Esq.*, 1881.	81.7.27.1	$43\frac{1}{4}$	$6\frac{1}{2}$	$18\frac{1}{2}$
Oryx beisa. Beisa Oryx .... *Presented by W. F. Sinclair, Esq.*, 1891.	91.7.29.1	$35\frac{3}{4}$	$6\frac{1}{2}$	$9\frac{1}{2}$
Oryx leucoryx. Arabian Oryx .... *Presented by B. T. Ffinch, Esq.*, 1890.	90.12.20.1	15	$3\frac{3}{8}$	$4\frac{1}{2}$
Oryx algazel. Scimitar Oryx .... *Presented by Capt. H. N. Dunn*, 1903.	3.2.8.39	$39\frac{3}{4}$	$6\frac{1}{4}$	$4\frac{1}{2}$
Addax masomaculatus. Addax .... *Presented by J. I. S. Whitaker, Esq.*, 1899.	99.1.2.1	$38\frac{1}{2}$	$6\frac{1}{2}$	$12\frac{1}{2}$
Antilope cervicapra. Blackbuck .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.81	$25\frac{3}{8}$	$5\frac{1}{2}$	$14\frac{1}{2}$

List of Horns, Antlers, and Tusks.

Hollow-horned Ruminant Horns (*continued*).

	No.	Length. in.	Girth. in.	Tip to tip. in.
Æpyceros melampus. Palla .... *Presented by Dr. Burchell.*	619 *a*	27½	5½	14¼
Saiga tatarica. Saiga .... *Bremen Geographical Society (per Dr. O. Finsch)*, 1878.	78.12.21.26	13⅝	5	5¼
Pantholops hodgsoni. Chiru .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.64	25⅜	5⅝	12½
Antidorcas euchore. Springbuck .... *Purchased from Argent*, 1846.	46.10.24.2	14	5¾	4¼
Gazella picticaudata. Tibetan Gazelle .... *Presented by A. O. Hume, Esq., C.B.*, 1891.		13½	3⅝	5¼
Gazella przewalskii. Przewalski's Gazelle .... *By exchange with St. Petersburg Museum*, 1897.	97.2.26.14	10¼	4⅜	2¾
Gazella gutturosa. Mongolian Gazelle .... *Bremen Geographical Society (per Dr. O. Finsch)*, 1878.	78.12.21.26	13¾	4½	6
Gazella subgutturosa. Goitred Gazelle .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.91	12⅜	4¾	5¼
Gazella dorcas. Dorcas Gazelle .... *Presented by Rowland Ward, Esq.*, 1892.	92.3.10.2	13⅜	3⅜	...
Gazella cuvieri. Cuvier's Gazelle .... *Presented by Rowland Ward, Esq.*, 1891.	91.4.18.13	13¼	4	4

Gazella arabica. Arabian Gazelle .... *Presented by W. T. Blanford, Esq.*, 1867.				
Gazella bennetti. Indian Gazelle .... *Presented by Lt.-Col. J. Evans*, 1889.	89.11.20.13	$12\frac{3}{8}$	4	$5\frac{1}{2}$
Gazella leptoceros. Loder's Gazelle........................ *Presented by Sir E. G. Loder, Bart.*, 1894.	94.6.4.3	$13\frac{1}{2}$	$3\frac{1}{2}$	10
Gazella isabella. Isabelline Gazelle........................ *Presented by W. T. Blanford, Esq.*, 1869.	69.10.24.2	$10\frac{1}{8}$	$3\frac{3}{4}$	4
Gazella tilonura. Muscat Gazelle .... *Purchased from E. Gerrard*, 1873.	73.2.24.8	$10\frac{3}{4}$	4	$2\frac{1}{8}$
Gazella rufifrons. Red-fronted Gazelle .... *Purchased*, 1846.	46.11.28.8	$6\frac{1}{4}$	$2\frac{1}{8}$	$2\frac{3}{8}$
Gazella thomsoni. Thomson's Gazelle .... *Presented by F. J. Jackson, Esq., C.B.*, 1891.	91.1.6.2	$15\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{3}{16}$
Gazella granti. Grant's Gazelle .... *Bequeathed by H. Andrew, Esq.*, 1904.	4.7.2.7	26	7	$11\frac{3}{4}$
Gazella petersi. Peters's Gazelle........................ *Presented by F. J. Jackson, Esq., C.B.*, 1892.	92.10.10.16	$22\frac{1}{8}$	$6\frac{3}{8}$	$5\frac{7}{8}$
Gazella sœmmerringi. Sœmmerring's Gazelle .... *Presented by Lt.-Gen. Sir A. Paget*, 1891.	91.12.3.3	16	5	$3\frac{1}{8}$
Gazella ruficollis. Red-necked Gazelle ... . *Purchased from Parreys.*	1742 *a*	$12\frac{1}{4}$	4	$5\frac{5}{8}$

List of Horns, Antlers, and Tusks.

HOLLOW-HORNED RUMINANT HORNS (*continued*).

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.
Gazella mhorr. Mhor Gazelle .... *Presented by W. Willshire, Esq.*, 1855.	55.12.24.279	$11\frac{3}{4}$	6	$3\frac{3}{4}$
Ammodorcas clarkei. Dibatag .... *Presented by T. W. H. Clarke, Esq.*, 1891.	91.12.19.8	$9\frac{3}{4}$	$4\frac{1}{2}$	$5\frac{1}{8}$
Lithocranius walleri. Gerenuk .... *Purchased from Mr. J. Menges*, 1891.	91.6.20.3	$13\frac{3}{4}$	$5\frac{3}{8}$	$2\frac{7}{8}$
Cervicapra arundinum. Reedbuck .... *Purchased*, 1846.	46.4.2.10	$15\frac{7}{8}$	$6\frac{1}{4}$	$14\frac{1}{4}$
Cervicapra fulvorufula. Mountain Reedbuck .... *Presented by Lord Hindlip*, 1902.	2.12.2.1	$5\frac{5}{8}$	$4\frac{3}{8}$	4
wardi Cervicapra redunca. Bohor Reedbuck .... *Purchased from Sir John Kirk*, 1882.	82.1.27.2	$13\frac{3}{4}$	$5\frac{1}{8}$	$8\frac{1}{8}$
Pelea capreolus. Vaal Rhebok .... *Presented by Dr. Burchell.*	629 *a*	$8\frac{5}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$
Cobus ellipsiprymnus. Waterbuck .... *Presented by F. C. Selous, Esq.*, 1883.	83.7.28.6	33	$9\frac{3}{8}$	$11\frac{1}{4}$
Cobus defassa. Defassa Waterbuck .... *Presented by Sir H. H. Johnston, K.C.B.*, 1901.	1.8.9.125	$34\frac{1}{8}$	$8\frac{3}{4}$	$20\frac{1}{4}$
Cobus maria. Mrs. Gray's Kob				

Cobus leucotis. White-eared Kob .... *Purchased from Consul J. Petherick*, 1859.				
Cobus cob. Buffon's Kob .... ***Presented by the Earl of Derby***, 1846.	46.10.17.5	$9\frac{1}{2}$	5	3
Cobus vaughani. Vaughan's Kob .... ***Presented by Capt. P. E. Vaughan***, 1906.	6.10.20.1	18	$5\frac{3}{4}$	$7\frac{3}{4}$
Cobus thomasi. Uganda Kob .... ***Presented by Sir H. H. Johnston, K.C.B.***, 1889.	89.1.2.6	$20\frac{1}{4}$	$7\frac{1}{4}$	$8\frac{3}{8}$
Cobus leche. Lichi or Lechwe .... *Purchased from F. C. Selous, Esq.*, 1881.	81.7.27.2	$27\frac{1}{2}$	$10\frac{3}{4}$	$19\frac{1}{8}$
Cobus vardoni. Puku .... ***Presented by Sir A. Sharpe, K.C.B.***, 1894.	94.3.8.10	$16\frac{1}{4}$	$6\frac{5}{8}$	$8\frac{1}{2}$
Oreotragus saltator. Klipspringer	? ?	$3\frac{3}{4}$	2	$1\frac{7}{8}$
Raphiceros campestris. Steinbok .... ***Presented by J. ff. Darling, Esq.***, 1897.	97.8.25.1	$4\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{4}$
Oribia nigricaudata. Black-tailed Oribi .... ***Presented by C. B. Mosse, Esq.***, 1876.	76.2.30.3	3	$1\frac{5}{8}$	$2\frac{3}{4}$
Oribia montana. Mountain Oribi .... *Purchased from E. Gerrard*, 1873.	73.8.29.10	$4\frac{3}{8}$	$1\frac{3}{4}$	$2\frac{1}{2}$
Oribia oribi. Oribi .... ***Presented by J. ff. Darling, Esq.***, 1897.	97.8.25.4	$6\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{2}$
Tetraceros quadricornis. Four-horned Antelope .... ***Presented by Lt.-Col. J. Evans***, 1889.	89.11.20.18 (back horn) (front horn)	4 $2\frac{1}{2}$	$1\frac{7}{8}$ $1\frac{7}{8}$	3 $1\frac{1}{2}$

List of Horns, Antlers, and Tusks.

Hollow-horned Ruminant Horns (*continued*).

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.
Cephalophus sylvicultor. Yellow-backed Duiker .... *Purchased from E. Gerrard*, 1878.	78.7.16.3	$6\frac{3}{4}$	$3\frac{3}{4}$	$4\frac{1}{2}$
Cephalophus grimmi. Cape Duiker-bok .... *Purchased from F. C. Selous, Esq.*, 1883.	83.7.27.3	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{7}{8}$
Connochætes taurinus. Brindled Gnu.................... *Collected by Sir Andrew Smith*, 1842.	42.4.11.10	22	12	$18\frac{3}{8}$
Connochætes gnu. White-tailed Gnu .... *Purchased from Argent*, 1848.	48.8.29.1	$20\frac{1}{4}$	$17\frac{1}{2}$	12
Bubalis boselaphus. Bubal Hartebeest .... *Presented by the Zoological Society*, 1859.	641 *e*. 59.2.10.1	$15\frac{1}{2}$	$8\frac{1}{2}$	$7\frac{3}{4}$
Bubalis major. Western Hartebeest .... *Purchased from E. Blyth, Esq.*, 1869.	69.2.9.1	$20\frac{3}{8}$	$10\frac{1}{4}$	7
Bubalis tora. Tora Hartebeest............................ *Purchased from Rowland Ward, Ltd.*, 1894.	94.4.26.1	20	$9\frac{5}{8}$	$15\frac{5}{8}$
Bubalis swaynei. Swayne's Hartebeest .... *Presented by Dr. P. L. Sclater*, 1892.	92.5.10.1	$16\frac{5}{8}$	$9\frac{1}{4}$	$20\frac{1}{4}$
Bubalis cokei. Coke's Hartebeest........................ *Purchased from F. J. Jackson, Esq.*, 1892.	92.10.18.3	$18\frac{1}{2}$	$10\frac{1}{4}$	$14\frac{1}{2}$
Bubalis cama. Cape Hartebeest .... [illegible]	42.4.11.6	23[illegible]	10	8[illegible]

Purchased from Rowland Ward, Ltd., 1900.				
Bubalis lichtensteini. Lichtenstein's Hartebeest .... *Purchased*, 1889.	89.7.1.3	19	$11\frac{1}{2}$	$4\frac{1}{8}$
Damaliscus hunteri. Hunter's Hartebeest .... *Presented by Dr. P. L. Sclater*, 1903.	3.1.13.2	$26\frac{3}{8}$	$8\frac{1}{4}$	$14\frac{1}{2}$
Damaliscus corrigum. Senegal Hartebeest .... *Presented by the Earl of Derby*, 1846.	643 *c.* 46.10.23.12	19	$6\frac{1}{4}$	10
Damaliscus tiang. Tiang Hartebeest .... *Presented by R. McD. Hawker, Esq.*, 1901.	1.8.8.48	$22\frac{3}{4}$	$8\frac{3}{4}$	9
Damaliscus jimela. Jimela Hartebeest .... *Purchased from F. J. Jackson, Esq., C.B.*, 1893.	93.4.10.4	$15\frac{1}{2}$	$6\frac{1}{2}$	$3\frac{1}{4}$
Damaliscus pygargus. Bontebok .... *Purchased from Warwick*, 1848.	48.7.13.6	$16\frac{3}{8}$	$6\frac{3}{4}$	$9\frac{1}{8}$
Damaliscus albifrons. Blesbok .... *Purchased from F. C. Selous, Esq.*, 1896.	96.11.28.1	$15\frac{1}{4}$	$6\frac{1}{2}$	10
Damaliscus lunatus. Sassaby .... *Collected by Sir Andrew Smith*, 1842.	42.4.11.5	$15\frac{1}{4}$	8	$12\frac{1}{4}$

C.—PRONGBUCK HORNS.

Antilocapra americana. Prongbuck .... *Presented by Captain G. Pearson*, 1905.	5.5.14.1	$14\frac{1}{2}$	$5\frac{3}{4}$	$11\frac{3}{4}$

List of Horns, Antlers, and Tusks.

D.—DEER ANTLERS.

	No.	*Length.* in.	*Girth.* in.	*Tip to tip.* in.	*Points.*
Rangifer tarandus arcticus. Barren Ground Reindeer or Caribou *Purchased from Argent*, 1851.	51.10.24.1	57⅝	5¼	13⅜	13+7
Rangifer tarandus osborni. Osborn's Caribou .... *Presented by F. C. Selous, Esq.*, 1907.	7.3.11.1	57¼	5¾	29¼	18+10
Alces machlis. Elk or Moose .... ***Presented by D. Davies, Esq.***	3.12.28.1	56	7¾	38	10+11
Cervus elaphus. Red Deer .... ***Presented by St. George Littledale, Esq.*, 1887.**	**87.12.22.4**	**46¾**	**5⅜**	**18**	**8+8**
Cervus elaphus. Red Deer .... **(single antler)** ***Presented by Lord Arthur Hay.***	**54.4.27.6**	**48½**			
Cervus cashmirianus. Kashmir Stag .... ***Presented by A. O. Hume, Esq., C.B.*, 1891.**	**91.8.7.2**	**45⅞**	**8**	**35**	**6+6**
Cervus yarcandensis. Yarkand Stag .... ***Presented by H. Lennard, Esq.*, 1892.**	**92.7.17.1**	**41½**	**6**	**31¼**	**6+6**
Cervus affinis. Shou or Sikhim Stag .... ***Presented by the Zoological Society (Dr. Campbell's Coll.)*, 1857.**	**57.12.14.3**	**54⅜**	**6⅝**	**21⅝**	**5+5**
Cervus albirostris. Lhasa Stag .... ***Presented by Dr. W. G. Thorold*, 1892.**	**92.10.11.1**	**38**	**5¼**	**28**	**5+5**
Cervus canadensis. Wapiti .... ***Purchased from H. Ward*, 1884.**	**84.5.28.1**	**57**	**7⅛**	**35⅛**	**6+6**
Cervus songaricus. Thian Shan Wapiti .. (single antler)	[illegible]	[illegible]	[illegible]		**7**

Presented by Gen. A. A. Kinloch, 1885.					
Cervus hortulorum. Pekin Deer .... *Presented by the Duke of Bedford, K.G.*, 1902.	2.10.2.2	$34\frac{1}{4}$	$5\frac{3}{4}$	$34\frac{1}{2}$	5+5
Cervus dama. Fallow Deer .... *Presented by the Duke of Bedford, K.G.*, 1896.	96.9.24.1	$25\frac{1}{2}$	4	14	11+8
Do. *Not identified*	......	$26\frac{7}{8}$	$\frac{3}{4}$	12	10+7
Cervus unicolor. Indian Sambar .... *Transferred from the India Museum (collected by Dr. H. Falconer)*, 1879.	79.11.21.444	$45\frac{1}{3}$	$6\frac{5}{8}$	$17\frac{3}{4}$	3+3
Cervus swinhoei. Formosan Sambar .... *Presented by the Zoological Society.*	1414 *a*	$19\frac{3}{4}$	$3\frac{1}{4}$	9	3+3
Cervus philippinus. Philippine Sambar .... *Purchased from Argent*, 1853.	53.10.6.2	$19\frac{5}{8}$	$5\frac{1}{4}$	$7\frac{1}{2}$	3+3
Cervus hippelaphus. Rusa Deer .... *Presented by B. H. Hodgson, Esq.*, 1845.	45.1.8.114	$37\frac{1}{2}$	5	$16\frac{3}{4}$	3+3
Cervus porcinus. Hog-Deer .... *Presented by E. le F. Davys, Esq.*, 1901.	1.9.7.2	$21\frac{5}{8}$	$3\frac{1}{4}$	$6\frac{5}{8}$	3+3
Cervus axis. Chital .... *Presented by A. O. Hume, Esq., C.B.*, 1891.	91.8.7.38	36	$4\frac{1}{4}$	$25\frac{1}{4}$	3+4
Cervus duvauceli. Swamp-Deer .... *Presented by B. H. Hodgson, Esq.*, 1845.	45.1.8.128	36	5	$29\frac{3}{4}$	6+5
Cervus schomburgki. Schomburgk's Deer .... *Purchased from Sir R. Schomburgk*, 1865.	65.11.2.3	$30\frac{1}{8}$	5	$15\frac{5}{8}$	10+10
Cervus eldi. Thamin .... *Presented by B. H. Hodgson, Esq.*, 1845.	45.1.8.126	$35\frac{1}{2}$	5	$30\frac{1}{2}$	4+4

$38\frac{1}{8}$ wide base

List of Horns, Antlers, and Tusks.

DEER ANTLERS (continued).

	No.	Length. in.	Girth. in.	Tip to tip. in.	Points.
Cervulus muntjac. Muntjac .... *Presented by B. H. Hodgson, Esq.*, 1843.	43.1.26.13	6½	2⅝	3½	2
Capreolus caprea. Roebuck .... *Presented by Earl Cawdor*, 1893.	93.1.3.1	8½	3	4½	3
Capreolus pygargus. Siberian Roe .... *Presented by Henry Elwes, Esq.*, 1898.	98.12.15.2	13¾	3	6	3
Elaphurus davidianus. Père David's Deer .... *Presented by the Duke of Bedford, K.G.*, 1898.	98.2.25.2	31	4¾	23	6+7
Dorcelaphus americanus. White-tailed Deer .... *No history.*	681 *d*	25	5	12⅛	6+10
Dorcelaphus hemionus. Mule-Deer .... *Purchased from H. Ward*, 1872.	72.12.12.3	19½	6½	11	5
Dorcelaphus dichotomus. Marsh-Deer .... *Purchased from Cutter*, 1871.	71.6.20.2	23⅜	5½	15¾	5+4
Dorcelaphus bezoarticus. Pampas Deer .... *Bravard Collection*, 1854.	686 *f*. 54.8.16.4	14⅝	2⅝	13¼	3+3
Xenelaphus antisiensis. Chilian Guemal .... *Purchased from H. Whitely*, 1874.	74.3.27.1	9½	7⅝	4⅝	2+2
Xenelaphus bisulcus. Patagonian Guemal	98.2.1.15	10½	3⅝	7¼	2+2

E.—ELEPHANT TUSKS.

	No.	Length. in.	Girth. in.	Weight. lbs.
Elephas africanus. African Elephant .... *Purchased*, 1901.	1.8.25.1	$121\frac{1}{2}$	24	228
Elephas maximus. Indian Elephant .... *Bequeathed by Col. G. M. Payne*, 1900.	0.2.26.1	$75\frac{1}{2}$	$17\frac{1}{4}$	77

F.—WALRUS TUSKS.

	No.	Length. in.	Girth. in.	Weight. lbs.
Odobænus obesus. Pacific Walrus .... *Presented by Major G. E. H. Barrett-Hamilton*, 1897.	97.1.18.1	$25\frac{5}{8}$	$8\frac{1}{2}$	—

G.—NARWHAL TUSKS.

	No.	Length. in.	Girth. in.	Weight. lbs.
Monodon monoceros. Narwhal .... *No history.*	No number	$103\frac{3}{4}$	$7\frac{1}{4}$	—

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4

GUIDE

TO THE

SPECIMENS

OF THE

HORSE FAMILY

(EQUIDÆ)

EXHIBITED IN

THE DEPARTMENT OF ZOOLOGY,

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

ILLUSTRATED BY 26 FIGURES.

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PREFACE

Owing to the great interest attaching to the Horse and its relatives (alike from the point of view of the naturalist, the breeder, and the sportsman) it has been decided to issue a special Guide-Book to the specimens of this group exhibited in the public Galleries of the Zoological Department of the Museum.

It is hoped that the following pages will not only tend to stimulate this interest, but that they will also lead to the presentation of "record" specimens for preservation in the National Collection. In the case of skeletons of celebrated thoroughbreds, Arabs, and other breeds, their true interest can only be fully appreciated when they are brought together in a large series. It is only in a great public museum that the proper care and preservation of such specimens can be assured.

The present Guide-Book is the work of Mr. R. Lydekker.

E. RAY LANKESTER,
Director.

British Museum (Natural History).
October, 1907.

GUIDE

TO

THE HORSE FAMILY.

The name "Horse." ALTHOUGH frequently employed in zoology in a wide sense, to indicate all the members of the family *Equidæ*, both living and extinct, the term "Horse" properly denotes only the well-known domesticated animal *Equus caballus* and its half-wild or wild representatives. Since, moreover, the Latin name was given by the Swedish naturalist Linnæus, it seems necessary to regard the domesticated Horses of Scandinavia as the typical representatives of the species.

In these pages the term Horse is mainly used in the more restricted sense.

Different views are entertained with regard to the limitations of the family *Equidæ*, some naturalists including in it all the extinct animals belonging to the same line of descent, or "phylum," while others restrict it to those more or less nearly related to the living species.

The Horse Family. In the latter sense the *Equidæ* are characterized by the tall prismatic crowns and complex structure of their cheek-teeth, in which all the hollows and valleys formed by the infoldings of enamel are filled by cement, so as to form a grinding surface of a perfect type. Another feature is the presence of an infolding of the enamel in the summits of the incisors, thus producing what is called the "mark." In the skull

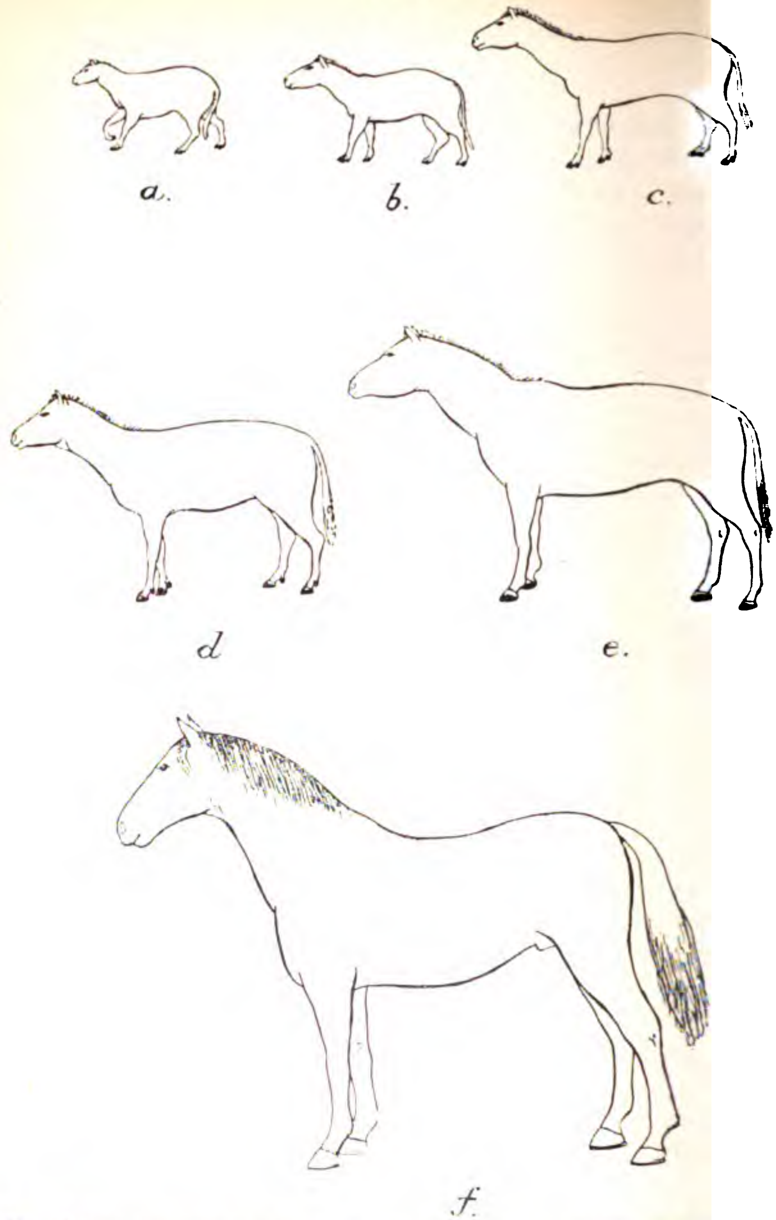
the enclosure of the socket of the eye by a complete bony ring is a feature distinctive of the group. In all existing members of the family, constituting the genus *Equus*, there is only one toe on each foot, although rudiments of lateral digits are represented by the "splint-bones" on each side of the upper end of the cannon-bones.

Dentition of the Horse. The dentition of the Horse is illustrated on one side of the table-case placed near the middle of the North Hall; the object of the specimens being to show the alterations which take place with age. In all its features the dentition displays special adaptation for the masticating of vegetable food, such as the herbage of the open plains upon which the species dwells in a state of nature. The front teeth or incisors are, for instance, used for cropping off the blades and stems of grass, while the cheek-teeth (molars and premolars) serve for crushing and breaking them into fragments. The tusks, or canines, so greatly developed in carnivorous animals, are comparatively small even in the males, and rudimentary in the females.

The complete number of teeth in the adult Horse is that characteristic of Ungulate or Hoofed Animals of the early Tertiary period, *viz.*, three incisors (*i*), one canine (*c*), four premolars (*p*), and three molars (*m*) on each side above and below, or forty-four in all. The first premolar (*p.* 1) is, however, very small, and often wanting, especially in the lower-jaw; but instances of its presence are shown in several specimens in the case; these being of interest, as remnants, on the point of disappearance, of a tooth well developed in the Horse-like Animals of ancient times.

The incisors, as mentioned above, have an infolding of the surface, constituting a deep pit (the "mark"), a feature now confined to the *Equidæ*. In consequence of this pit extending only a certain depth into the crown, it becomes obliterated as the tooth wears away, so that its presence is a guide to the age of the animal. The six principal cheek-teeth are in close contact by broad surfaces fitting tightly against each other, so that they collectively form one solid mass, presenting a grinding-surface composed of substances of various degrees of hardness (enamel, dentine, and cement), interwoven into an intricate pattern so as to make most efficient natural millstones. The

FIG. 1.



THE ANCESTORS OF THE HORSE AND ITS RELATIVES COMPARED IN SIZE AND FORM WITH THEIR TYPICAL MODERN REPRESENTATIVE.

a. Hyracotherium or *Protorohippus*, of the Lower Eocene; *b. Plagiolophus* or *Orohippus*, of the Middle Eocene; *c. Mesohippus*, of the Oligocene; *d. Merychippus*, of the Miocene; *e. Pliohippus*, of the Pliocene; *f.* The Modern Horse, *Equus caballus*, domesticated breed. (Lull, *Amer. J. Sci.* vol. xxiii, p. 167.)

[*To face page* 5.

grinding-face of the tooth always keeps at the same level, the gradual wear of the superficial parts being compensated by the pushing outwards of the whole tooth in its socket until, as may be seen in the older specimens, nothing but the root is left.

The permanent teeth are preceded by a temporary or deciduous set of "milk-teeth" (*d.i.*, *d.m.*, &c.); in which there are as many incisors as in the permanent set, although there are only three cheek-teeth on each side above and below; these milk-molars being replaced by the last three permanent premolars. The eruption, or cutting through the gums, of the deciduous teeth commences at about the time of birth, and is completed before the end of the first year, when the young animal has its full set; the upper teeth, as a rule, appearing somewhat earlier than those of the lower jaw. The first teeth to appear are the central incisors and the molars; between the first and second months the second incisor appears, and finally (at about nine months) the third (corner) incisor, which completes the milk-dentition. Of the permanent teeth, the first molar appears about the end of the first year, followed by the second molar before the end of the second year; these teeth being thus in place before any of the milk-teeth have been shed. At about two and a half years the second and third premolars replace their predecessors; and between two-and-a-half and three years the first permanent incisor appears. At three-and-a-half to four years the fourth premolar, the third true molar, and the second incisor have appeared; while at four-and-a-half to five years the third (corner) incisor and the canine have cut the gum, thus completing the permanent dentition. Up to this period the age of the horse is clearly shown by the condition of its teeth, and for some years longer indications can be obtained from the wear of the incisors, though this depends to a considerable extent upon the hardness of the food and other accidental circumstances.

In the specimens exhibited the side view of the teeth of the right side, and the grinding-surface of the teeth of the left side are shown.

The series of skulls exhibited comprises specimens ranging in age from the unborn colt to a horse of 36 years.

Skeleton of Man & Horse. Facing the visitor as he enters the middle of the north hall are shown in a single case the skeletons of a Man and of a Horse (N.H. 1), arranged for comparison with each other, and also to show the position of the bones of both in relation to the external surface. In the case of the Horse, the skin of the animal from which the skeleton was prepared was mounted, and, when dry, divided in the middle line, and one half, lined with velvet, placed behind the skeleton. In the Man the external surface is shown by a *papier-maché* model, similarly lined and placed in a corresponding position. The principal bones of both skeletons have their names attached, so that study of this group, besides affording a lesson in comparative anatomy, may be of practical utility to artists. The meanings of the terms pastern, fetlock, etc. are also explained in this specimen.

Evolution of the Horse. Specimens illustrative of the evolution of the Horse are displayed on the north side of the table-case near the middle of the north hall; that is to say in the same case which contains, on the south side, the series illustrating the dentition of the Horse.

The evolution of the Horse (and its allies) is better known than that of any other group of Mammals. In passing from the Horse to its earlier ancestors, a gradual decrease in bodily size (fig. 1), accompanied by a shortening of the lower segments of the limb, especially of the bones of the foot, is very noticeable; at the same time there is an increase in the number of the toes, while the height of the crowns of the cheek-teeth is lowered, and their structure becomes simpler.

In the Horse, in common with the other members of the genus *Equus*, the skull (fig. 13) has the socket of the eye completely surrounded by bone, there is no distinct depression immediately in front of the same, the canine and incisor teeth are separated by a long gap from those of the cheek-series, and the crowns of the latter are very tall and continue to grow till late in life, while their grinding-surfaces are much complicated, owing to the filling-up of all the cavities with the substance known as cement. Each limb terminates in a single hoof, upon which alone the animal walks;

FIG. 2.

SKELETON OF FORE-FEET OF EXTINCT FORE-RUNNERS OF THE HORSE:
A. *Hyracotherium* (No. N. H. 65); B. *Mesohippus* (No. N. H. 57); C. *Merychip*
or *Protohippus* (No. N. H. 57): D. *Hipparion* (No. N. H. 44).

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the lateral toes being represented only by the so-called "splint-bones" (fig. 7).

Remains of Horses indistinguishable from some of the various forms of the existing species occur in the superficial deposits of Europe and Asia, in company with those of the Mammoth. At a somewhat earlier epoch (Pliocene) occur Horses, such as *E. stenonis* of Europe and *E. sivalensis* of India, in which the head is relatively larger, the feet are somewhat smaller, the splint-bones more developed, and the skull shows traces of a depression in front of the eye. The American *Pliohippus* is smaller, with shorter cheek-teeth. Still earlier (Miocene) is found in America a Horse known as *Merychippus* or *Protohippus* in which the splint-bones are fully developed and terminate inferiorly in small, although perfect, toes. In the early Pliocene *Hipparion*, or three-toed Horse, the lateral toes are still larger, while the crowns of the cheek-teeth are lower, and the skull is shorter and shows a large depression in front of the eye. In this animal the crowns of the cheek-teeth are still tall and have their hollows filled with cement (fig. 6, E), and there must consequently be some unknown forms connecting it with the Miocene *Anchitherium*, in which the crowns of these teeth are quite short, and have their hollows free from cement. *Hipparion* is generally regarded as off the direct ancestral line.

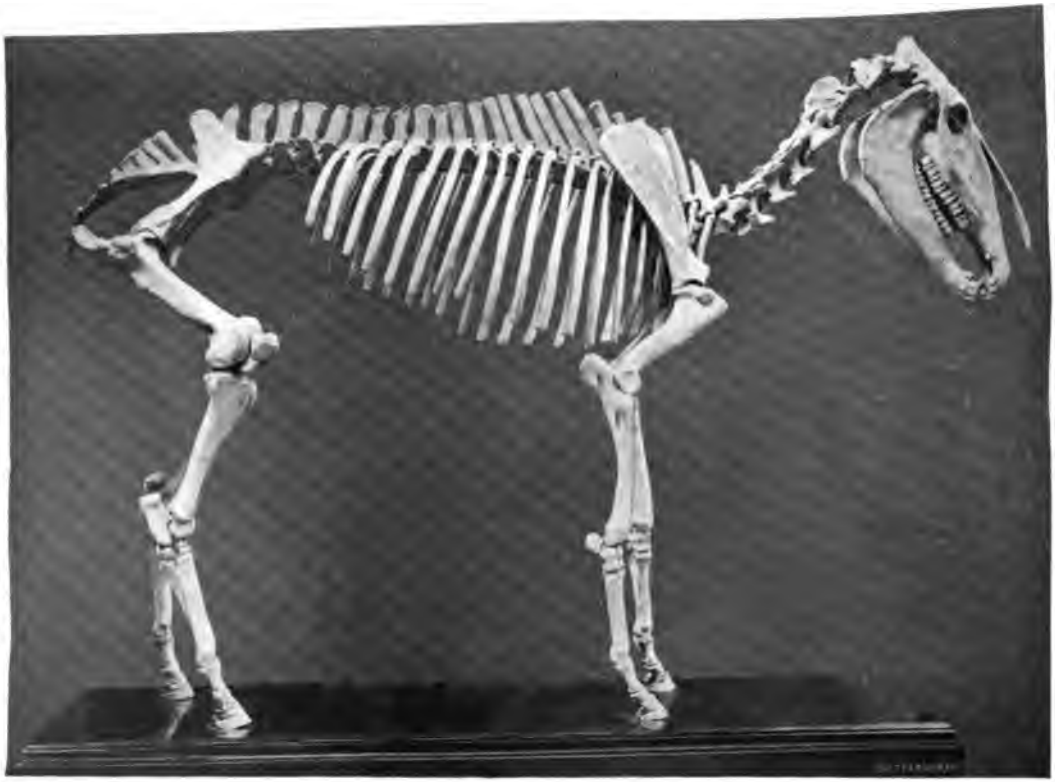
This type is common to Europe, Asia, and North America; but Mr. J. W. Gidley, in the *Bulletin* of the American Museum, has come to the conclusion that the New World Hipparions are generically distinct, and proposes that they should be known as *Neohipparion*. They differ from the Old World forms by certain details of tooth-structure, as well as by their more slender limbs, in which it seems that the lateral toes are relatively smaller. Finally, they are of Miocene, instead of Pliocene, age.

Nearly allied to *Anchitherium* is the Oligocene genus *Mesohippus*, the species of which are smaller than the typical representative of the former. In these animals the socket of the eye is open behind, the gap between the canine and cheek-teeth is comparatively short, the lateral toes are functional, and there is even a suggestion of a fourth toe in the fore-foot (fig. 2, B). This digit is fully developed in the fore-foot (fig. 2, A) of *Hyracotherium*, a Lower

Eocene Mammal not larger than a Fox, in which the lateral digits of both feet are relatively as large as in the Tapir, while all the bones of the feet are proportionately shorter than in the Horse, and all three joints of each toe probably touched the ground. Species intermediate between *Mesohippus* and *Hyracotherium* have been named *Plagiolophus* and *Orohippus*. Farther it is not at present possible to carry the ancestry of the Horse, but there is little doubt that *Hyracotherium* is descended from a still earlier five-toed Mammal with a simpler type of cheek-teeth, and much shorter foot-bones. This hypothetical animal doubtless walked on the whole sole of its foot (plantigrade progression) instead of on the tips of the toes, and was probably nearly related to the creature known as *Phenacodus*, a cast of the skeleton of which is exhibited in the Gallery of Fossil Mammals. For further details concerning the extinct allies of the Horse see 'A Guide to the Fossil Mammals and Birds in the Department of Geology and Palæontology'.

South American Extinct Horses. The superficial (Pleistocene) deposits of South America—more especially those of the province of Buenos Aires—have yielded remains of two very remarkable equine animals, *Hippidium neogæum* and *Onohippidium munizi*. Of the former the model* of a nearly entire skeleton (N.H. **3**, fig. 3) is exhibited, while the latter is represented by a cast of the skull (N.H. **17**). In both genera the cheek-teeth (as mentioned later) have shorter crowns and differ in several details of structure from those of modern Horses. As mounted, the skeleton stands 4 ft. 1 in., or 12¼ hands, at the withers, while the skull measures 23½ in. in total length. In an average European horse-skeleton, standing 4 ft. 9½ in., or 14 hands 1¼ in. at the shoulder, the skull-length is about 23¾ in., or practically the same as in the much smaller *Hippidium*. Although these measurements suffice to show how disproportionately large is the skull of the *Hippidium*, they by no means indicate the chief peculiarities of that animal. Comparison of the skull of the former with that of an ordinary Horse shows a most remarkable difference in the structure of the nasal region of the two species. In the ordinary Horse the nasal bones are separated from the maxillæ, or upper jaw-bones, of either side by a slit of only some

* The original of this model has been made the type of a second species, but on very slight grounds.



SKELETON OF *Hippidium neogæum*, about $\frac{1}{14}$ nat. size.
(From the model in the Museum (No. N. H. 3); the femur, or thigh-bone, is too much inclined.)

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FIG. 4.

SKULL OF *Onohippidium munizi.* (From the model in the Museum, No. N. H. 17). *pf.* preorbital fossa, or depression. About $\frac{1}{6}$ nat. size.

FIG. 5.

SKULL OF A SMALL S. AMERICAN DEER, *Pudua pudu* (No. N. H. 17), to show the preorbital fossa, or depression (*pf.*), which contains a gland. $\frac{3}{4}$ nat. size.

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three or four inches in length. In *Hippidium* (as in *Onohippidium*, fig. 4), on the other hand, these slits are about 10½ in. long, while the nasal bones themselves are proportionately long and slender. This clearly indicates that these extinct American Horses had extremely elongated noses, not improbably forming a kind of short trunk comparable to that of the Saiga Antelope.

In that animal, as well as in its relative the Chiru Antelope of Tibet, the increased size of the nasal chamber has been brought about by a shortening instead of an elongation of the nasal bones, but it is probable that in these two Antelopes and in the *Hippidium* the purpose of the modification is the same. It has been generally supposed that in the case of the Chiru the large size of the nasal chamber is an adaptation to the respiratory needs of an animal living at a very high elevation. In the case of the Saiga such an explanation would, however, obviously not hold good; and the real explanation in all three cases may perhaps be found in a special adaptation to a desert life, the long nose serving as a filter to prevent particles of sand reaching the organ of smell.

As regards the rest of its skeleton, *Hippidium* is remarkable for its short and stout limbs; this being chiefly due to the excessive shortness of the cannon-bones, which are also unusually wide, with very stout splint-bones. Each limb terminates in a single toe. These short limbs, coupled with the huge unwieldy head, indicate that *Hippidium* had less speed than ordinary ponies. There are only five lumbar, or ribless trunk, vertebræ, as in the Arabian Horse.

Two other points of interest in connection with these peculiar equine animals deserve brief reference. From the conformation of the bones of the nasal region it seems certain that neither *Hippidium* or *Onohippidium* can be derivatives from the genus *Equus*, while it is still more evident that *Equus* cannot be descended from *Hippidium*. Consequently, the reduction of the digits from three in the ancestral Horses to a single one on each foot has taken place independently in the two genera. The second point is that if the wild Horses alleged to have been seen by Cabot in Argentina in the year 1530 really were, as some suppose, indigenous, they must have been either *Hippidium* or *Onohippidium*, and not Horses of the Old World type. With the evidence afforded by the skins of the Patagonian Ground-Sloth as to the

comparatively late date to which that species survived, there is no valid reason why *Hippidium* and *Onohippidium* should not have survived till Cabot's time, especially as their hoofs have been found in comparatively fresh condition alongside the remains of the Ground-Sloth.

While the skull of *Hippidium* shows no marked depression in front of the eye-socket, that of *Onohippidium* (fig. 4) has an enormous pit in this position, with a smaller and partially detached one in front.

Teeth of Extinct Horses. In the same case with the skull of *Onohippidium* are exhibited a few specimens (N.H. **34**) illustrating the structural differences in the upper cheek-teeth of some of the later members of the *Equidæ*, and also the marked difference between an unworn and a worn molar of *Equus caballus*. The specimen marked A (fig. 6, A) is an unworn molar tooth of the latter species, with the infoldings of the crown not yet filled with the cement, which is developed later. D (fig. 6, D) shows the condition of a similar tooth which has been some time in use. The summits of the columns coloured red in A have been worn away in D so as to expose the dentine or ivory (red) forming the interior of the tooth; the infoldings on the crown, of which the central ones are converted into islets, being filled with cement (blue). The enamel, forming the proper external surface of the tooth, is left of the natural colour. Specimen C (fig. 6, C) is a half-worn tooth of the above-mentioned extinct South American *Hippidium*, in which the two disks (anterior and posterior pillars) on the lower border coloured red are more alike than in *Equus*; the whole crown of the tooth being also shorter. Specimens B and E are respectively slightly worn and half-worn teeth (fig. 6, B & E) of the European Three-toed *Hipparion*. In these the anterior pillar (*a*) is isolated from the rest of the crown, thus indicating that the genus is off the direct line of ancestry of the modern representatives of the Horse family.

Callosities or "Chestnuts." Although it is unnecessary to discuss the general structure of the *Equidæ*, it is important to mention that all members of the Horse tribe have a bare patch of hardened skin on the inner side of the fore-leg, situated some distance above the carpus, or "knee." In the Horse a similar but smaller callosity, or "chestnut" generally

CROWN SURFACES OF MOLAR TEETH OF *Equus* (**A.** & **D.**), *Hippidium* (**C.**), and *Hipparion* (**B.** & **E.**) (No. N. II. 34).
a. anterior, *b.* posterior pillar.

BACK OF THE FORE AND HIND CANNON-BONES AND SPLINT-BONES OF A SHIRE HORSE (No. N. H. 38).
1 & 2. Bones of the rudimentary lateral toes.

(From specimens in the Museum.)

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occurs on the inner side of the hind-limb some distance below the tarsus, or hock (fig. 8). This hind-callosity is absent in certain ponies from Iceland and the Hebrides as well as, it is reported, in some horses from North Africa; and is always wanting in the Ass, the Zebras, and all other members of the family. The front callosity is more warty in the Horse than in any other species of the family.

These structures are evidently of the type commonly called rudimentary, that is to say, they are the decadent remnants of organs once functional. They have been regarded as representing glands. Important evidence in favour of this view is the fact that when cut the callosities yield a fluid which will attract other horses, and will likewise cause dogs to keep quiet when the premises of their masters are invaded; such a fluid being almost certainly derived from an ancestral scent-gland.

Specimens of the legs of the Horse (N.H. **71**, **72**), Ass (N.H. **69**, **70**), and Zebra (N.H. **68**) are exhibited in the large case in the central archway on the north side of the hall to illustrate these remarkable structures. Near by are shown in spirit portions of the hind-legs of two unborn colts (N.H. **96**, **96** A) in order to demonstrate that the position of the calosity (fig. 9) is the same as in the adult, and thus to refute the suggestion that these structures represent one of the foot-pads of less specialized Mammals.

In the same case are displayed specimens of the limbs of Deer with glands situated in positions not very dissimilar to those occupied by the callosities of the Horse.

In old veterinary books the callosities, which were supposed to be due to disease, are called sallenders (from the French *Solandre*), or mallenders. They are sometimes called "castors."

The Ergot. The true representative of a foot-pad is the "ergot," or small horny knob projecting from the hind surface of the fetlock of the Horse. A specimen (N.H. **93**, fig. 10) showing this is displayed in the same case, where the foot of a Tapir (N.H. **94**, fig. 11, A) and another of a Dog (N.H. **95**, fig. 11, B) are also exhibited, in order to show the correspondence of the central pad with the Horse's ergot.

"Horned Horses." In this place certain interesting abnormalities which occasionally make their appearance in Horses may be conveniently noticed. The most remarkably of these are connected with the skull. The specimens exhibited include

the skull of an English Horse (N.H. **45**) presented by Mr. Hanbury Carlile, showing rudiments of a pair of horns on the forehead. Of three other specimens of the same type, one is the frontal region of the skull of an ordinary English Horse (N.H. **44**) showing the pair of rudimentary horns in precisely the same position as in the first specimen, but of somewhat larger size. The other two are models of the foreheads of Thoroughbreds (N.H. **46**, **47**), each showing a pair of similar horns, situated as in the preceding specimens. These are important as showing that the skin extends uniformly over the horn-like processes, without any trace of a dermal horn; the same condition being observable in the other two examples. The significance of these horn-like growths is at present inexplicable, seeing that none of the ancestral Horses, or even of the collateral branches of the Horse-stock, were horned animals. This makes it the more difficult to understand why the projections in all the four specimens above referred to should be so similar in form and position.

Bones of the Foot. The next abnormalities to be mentioned are connected with the foot-bones of Shire Horses, as represented in the feet of "Blaisdon Conqueror," formerly owned by Mr. Peter Stubs and of two other Horses of the same breed presented respectively by Lord Wantage and Lady Wantage. In the skeleton of "Prince ~~Henry~~," William presented by Lady Wantage, only the bones of the limbs on the left side (N.H. **38**) have been preserved; but in both the front and hind cannon-bones (fig. 7) of that side the two lateral splint-bones (the metapodials of anatomists) are unusually large and stout. In place of terminating, as in many ordinary Horses, about two-thirds down the shaft of the cannon-bone, or even less, in thin narrow slips, they extend fully four-fifths the length of the latter, where they end in large triangular processes inclined markedly outwards. Although these terminal projections are immovably welded to the splint-bones, their structure is such as to indicate that they represent distinct elements, consisting of two or three pieces each; and there can be no doubt that they really correspond to the lateral toe-bones (phalanges) of the extinct Hipparion. In other words, Lady Wantage's Shire may be said to be a veritable three-toed Horse,

Fig. 8.

The Callosities on the Fore- (A.) & Hind- (B.) Legs of the Horse (Nos. N. H. 71, 72).

Fig. 9.

The Callosity on the Fore-leg of an Unborn Colt (No. N. H. 86).

(From specimens in the Museum.)

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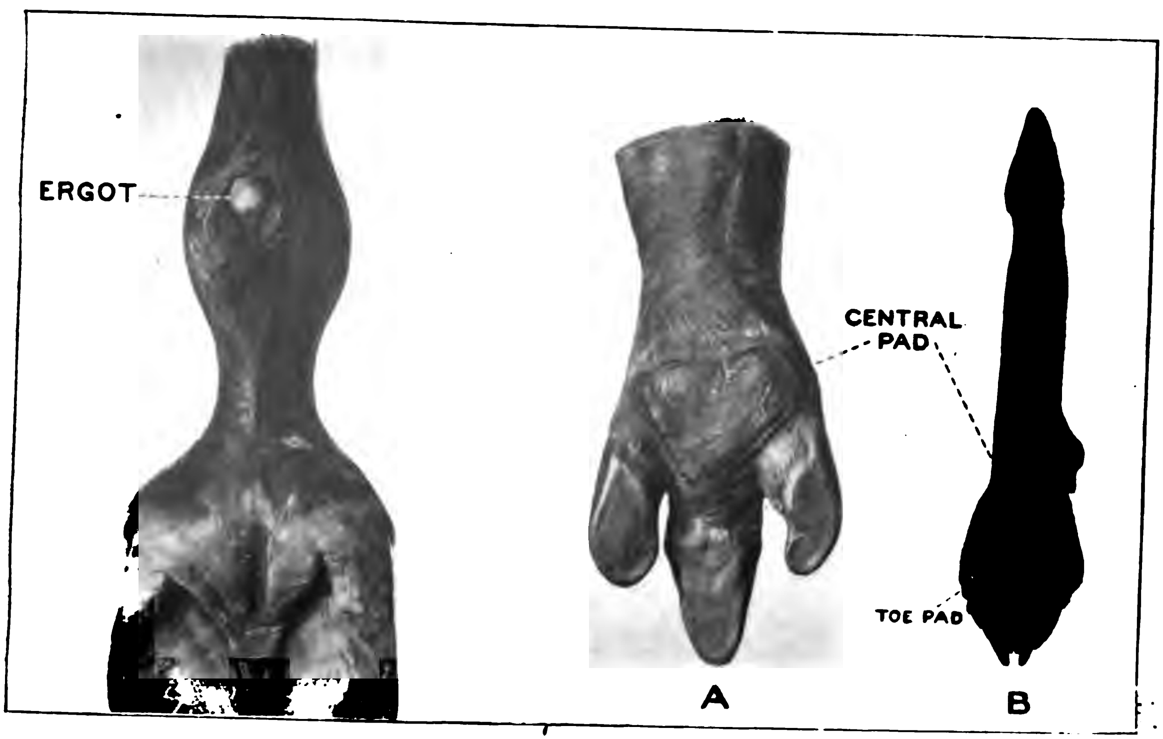
Fig. 10.

Fig. 11.



Horse.
Hind surface of the Foot of a Horse,

Tapir. Dog.

in which the bones of the rudimentary lateral toes were buried in the skin and welded together. It is noticeable that, in both the fore and hind foot, the outer rudimentary toe-bones are much more developed on the left than on the opposite side.

If this were all, it might be considered that the Shire "Prince Henry" was merely a solitary instance of reversion towards the ancestral type in foot-structure, and, although even this would be a matter of considerable interest, yet it would have little or no special bearing on the ancestry of the breed in general. Since, however, the cannon-bones of "Blaisdon Conqueror" also display an equally large development of the splint-bones, which show traces at their lower ends of distinct vestiges of the toe-bones, although by no means in so pronounced a degree as in "Prince Henry," the peculiarity seems to be more deeply seated. It is true, indeed, that in the case of the feet (N.H. **77, 78**) and limb-bones (N.H. **79, 80**) of a Shire colt presented by Lord Wantage, it has to be admitted that these are abnormal and more or less malformed; yet, the fact remains that they show not only traces, but a relatively high degree of development of the lateral toes, of which the constituent bones are separate, while the terminal one on one side of each limb has a hoof of its own. The reversion to the ancestral type is thus very strong. In both feet of this colt the lateral (2nd and 4th) metacarpal bones (usually represented only by the so-called splint-bones) are complete, though varying in size, and carry one toe-bone each.

Although this abnormal specimen was selected and presented to the museum on account of its peculiarities, yet, after making allowance for this, there is the remarkable fact that three skeletons of Shire Horses exhibit more or less strongly developed rudiments of the lateral toes of the extinct three-toed Hipparion. The obvious inference is that this is a characteristic of the breed.

To confirm or disprove this idea requires, however, the limb-bones of a considerable series of pedigree Shires. Of special value would be the limb-bones of very young colts, in which the rudimentary toe-bones might be separate and more fully developed than in the adult. As matters already stand, a further inference may, however, be drawn from these rudimentary toes in the Shire Horse. As already stated, in many Horses the splint-bones

terminate inferiorly in thin scale-like extremities. In some instances, however (as in the fore limb of Stockwell, exhibited in a wall-case), they have a small flat expansion at the lower end, and from the evidence of the Shire Horse bones these expansions may be definitely identified with the lateral toe-bones of the three-toed ancestors of the Horse. In a certain sense, therefore, a considerable number of existing Horses are really three-toed animals.

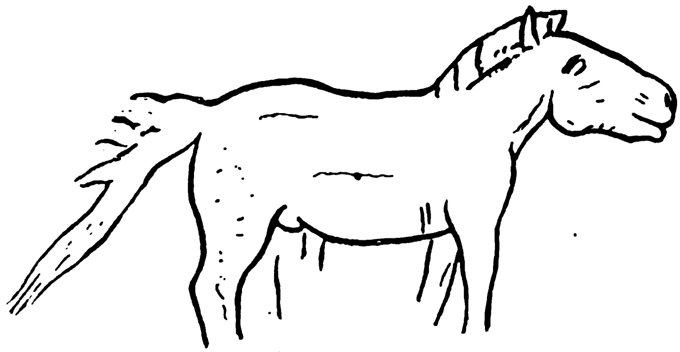
Whether the highly developed condition of the splint-bones and rudimentary toe-bones of the Shire Horse indicates an ancestry for that breed distinct from either the Arab thoroughbred stock on the one hand, and the ordinary North European stock on the other, or whether it is merely a kind of reversionary redundancy due to the large size and vigour of the Shire, is difficult to decide.

Variation of another type has formed the subject of a paper by Mr. O. C. Bradley in the *Proceedings* of the Edinburgh Physical Society. The trapezium of the carpus of the Horse is the structure discussed; and it is shown that this bone is present, either in one or both limbs, in about 50 per cent. of the skeletons examined, while if each carpus be taken separately (that is, without reference to the condition in its fellow) the percentage is a little more than 40. This, in conjunction with its minute size, leads to the conclusion that in the evolution of the single-toed foot of the Horse the bone in question is following in the steps of the lateral metacarpal (splint-bone) with which it was originally connected.

Variation in the Shape of the Hoof in the Horse Family.

Another point of interest is the existence of a considerable amount of difference in the structure of the hoof in the various members of the Horse tribe; this being illustrated by a series of specimens (N.H. **81–89**) in the large case on the north side of the North Hall. In the Horse (*Equus caballus*) the "frog," or central cushion is reduced to a narrow ridge, deeply grooved posteriorly, which does not extend behind the case of the hoof, and is not applied to the ground. In Grévy's Zebra (*E. grevyi*), of North-east Africa, the frog becomes much broader, with scarcely any trace of the groove, and its hind part touches the ground. In the Kiang (*E. hemionus kiang*), of Tibet, the posterior development of the frog becomes more marked, so that a considerable portion projects behind the case of the hoof and

Fig. 12.



The Cave-Horse: from a Prehistoric Sketch.

Fig. 13.

Skull of the Mongolian Wild Horse, Female (No. N. H. 16).

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touches the ground; the cleft being narrow and deep. A still greater development of the hind part of the frog occurs in the Ass (*E. asinus*). In the extinct South American *Onohippidium* the frog is somewhat intermediate between the Horse and the Ass type, being grooved and not projecting behind the case of the hoof, but being of considerable breadth and thickness. In the Bonte-Quagga or Burchell's Zebra (*Equus burchelli*) of South and Eastern Africa the medium-sized and slightly cleft frog is deeply sunk in the hoof, behind which it projects to a small degree; not touching the ground, except when the hoof is much worn.

Characteristics of the Horse. Coming to the characteristics of the Horse itself, as typified by the domesticated Scandinavian breed, the species is distinguished by the tail being abundantly covered with long hair up to the root and the general presence of bare callosities or, "chestnuts," on the inner side of both pairs of limbs. The mane, which has a forelock on the forehead, is long and pendant, the ears are relatively short, the head small, the limbs long, and the hoofs large and broad, especially the front pair, which considerably exceed the hind ones in this respect. Normally there are no distinct colour-markings; although dark bars are not unfrequently seen on the legs, and more rarely on the shoulders, of dun-coloured individuals.

This definition requires, however, some amount of modification when the wild representatives of the species are taken into consideration. The following main types or races of the Horse may be recognized, of which the first is :—

The Cave Horse. The Cave Horse, *Equus caballus spelæus*, a race typified by bones and teeth from the cavern of Bruniquel, Tarn-et-Garonne, France, described by Sir R. Owen in the *Philosophical Transactions of the Royal Society* for 1869, and exhibited in the Geological Department. It was then supposed to indicate an animal of about 13½ hands in height, but the relatively large size of the cheek-teeth of the next race indicates that it was probably much smaller. Prehistoric sketches from the Cave of La Madelaine, in the Dordogne, south of France (fig. 12), show that this race was practically identical with the living Wild Horse of Mongolia, having the same relatively large

head, absence of forelock, upright mane, and tail sparsely haired at the root. Indeed, the grounds for separating this race from the next are based on considerations of nomenclature and convenience rather than on structural differences. Nevertheless, the cheek-teeth appear to be relatively and absolutely smaller in the cavern race, the length of the row of six upper teeth in a specimen from Bruniquel being about $7\frac{1}{4}$ inches.

Skulls from the superficial deposits of Walthamstow, Essex, of which one (N.H. **18**) is exhibited in the table-case, probably indicate a race nearly allied to, if not identical with, the Cave-Horse. As in the Mongolian Wild Horse, the face is bent downwards only in a slight degree on the line of the basal axis of the skull.

Mongolian Wild Horse. The Mongolian Wild Horse (*Equus caballus przevalskii*, fig. 14) is a small race, standing about 12 hands at the shoulder, and characterised by the root of the tail being short-haired, a short upright mane, the absence of a forelock, and the yellow dun or somewhat rufous body-colour, with the mane and tail black, the legs dark brown or black, at least as high as the fetlocks, a narrow dark stripe down the back, and generally (probably always when pure-bred) a white muzzle. The head is relatively large, especially as regards the face, the ears are proportionately tall, and the hoofs rather narrow. The interval between the first upper cheek-tooth and the outermost incisor is relatively very short. The cheek-teeth (fig. 16, A) are both absolutely and relatively very large, the length of the upper row of six in a skull with a basal length of $18\frac{7}{8}$ inches being $7\frac{1}{2}$ inches, or only one-quarter of an inch less than in the skull of the Shire Mare "Starlight" (N.H. **23**, fig. 16, B), of which the basal length is 23 inches. Other distinctive features of the upper cheek-teeth are the absence of complex foldings in the enamel and the relatively large size (antero-posteriorly) of the anterior pillar (*a*), which is produced considerably in advance of the point of connection with the main body of the tooth, and is much flattened on the inner side. This feature is most pronounced in the premolars. The large relative size of the cheek-teeth is illustrated by comparison with those of a Dartmoor Pony skull (N.H. **27**),

Fig. 14.

The Mongolian Wild Horse.
(From the female specimen presented by the Duke of Bedford.)

Fig. 15.

The Darley Arabian.
From the original picture at Aldby Park, York.

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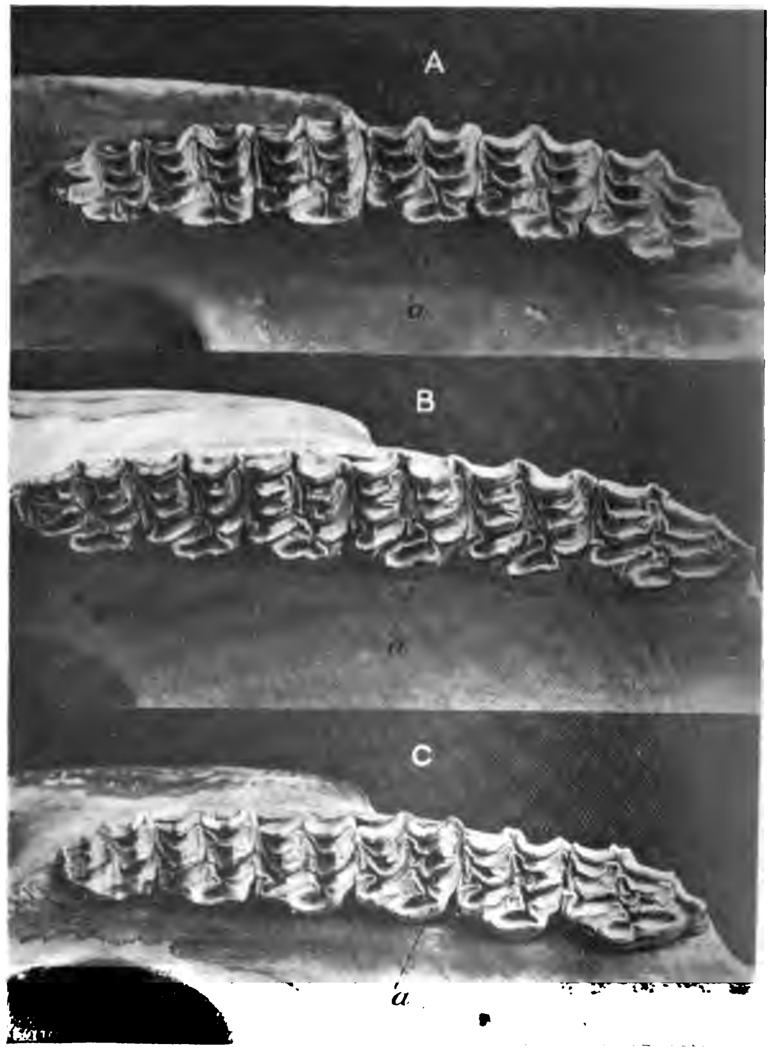
Fig. 16.



Right Upper Cheek-Teeth of the Mongolian Wild Horse, (**A**); a Shire Horse, (**B**); and an Arab, (**C**) $\frac{1}{2}$ nat. size. *a*, anterior pillar.

[*To face page* 15.

but little smaller than that of the female skull of the Mongolian Wild Horse. In the Dartmoor Pony the length of the tooth-row is only 5¾ inches.

In addition to the length of its facial portion, the skull of the Wild Horse here exhibited (N.H. 16, fig. 13) is characterised by the absence of any distinct vestige of a depression in front of the eye-socket, and by the slight extent to which the face is bent down on the basi-cranial axis, so that a continuation of the line of the latter will cut the face above the aperture of the nose-cavity *.

In some instances there are indistinct transverse barrings on the legs, and there may be faint indications of a shoulder-stripe.

In its typical form the Wild Horse appears to be restricted to the Gobi Desert and perhaps some of the neighbouring districts; but the Wild Horses formerly inhabiting the Kirghiz Steppes and known as Tarpan, were evidently near akin. They were probably, however, crossed to a greater or less degree with escaped domesticated Horses; and the few skins which have been preserved show decisive evidence of mixed blood in their mouse-coloured coats, such a tint among Horses being a sure indication of cross-breeding. In the early part of last century, when Tarpan were still numerous on the Kirghiz Steppes, the Taters asserted that the pure breed was to be met with only to the far eastward, in Central Asia—that is to say the Gobi Desert; and it accordingly seems probable that the Mongolian Wild Horse itself ought properly to be called Tarpan, or, in the plural, Tarpani.

A small Horse living in London in the early part of last century and stated to have come from the heart of China was named *Asinus equuleus* by Colonel Hamilton Smith. If, as seems possible, this animal was a true Wild Horse, the name *equuleus*, as the earlier, should replace *przevalskii*.

* Prof. J. C. Ewart, *Trans. Roy. Soc. Edinburgh*, vol. xlv, 1907, p. 555, and *Quarterly Review*, April 1907, p. 547, has made the Mongolian Wild Horse the type of a so-called "Steppe-group" characterised by the marked deflection of the facial portion of the skull as compared with the basal axis. No such feature is, however, presented by any of the skulls of this race in the Museum Collection, although it is apparent to some extent in the one figured in the first of the two memoirs mentioned.

A mounted specimen of a female of the Wild Mongolian Horse (M. **1012**, fig. 14) is exhibited in the Lower Mammal Gallery, and the skeleton of a young stallion is installed in the North Hall, where the two halves of the skull of the mare are also shown.

Some of the Kirghiz Tarpan lacked the hind chestnuts (which are small in the Wild Mongolian Horse); and these structures appear to be constantly lacking in a breed of small Horses or Ponies ranging from Connemara, the Outer Hebrides, Iceland, and the Faroes to Western Norway. For this breed the name of Celtic Pony, or Celtic Horse (*Equus caballus celticus*) has been proposed; but since it has also been regarded as nearly related to the Kirghiz Tarpan *, it seems doubtful whether it is worthy of racial separation from *E. c. przevalskii*. The Celtic Pony, or Fjordhest as it is called in Norway, has been described as follows:—

The ordinary colour is pale buff, but may be mouse-grey, or even brown; the mane is light-coloured externally, with a central black core, and the tail is also light-coloured with a certain admixture of black hairs. The winter coat is very rough and shaggy, with a large forelock and tuft of hair under the lower jaw, and long bushy hair at the root of the tail. The forehead is broad, and the facial portion of the head relatively short; while the legs are relatively slender and the hoofs small. The absence of hind callosities has been already noted. Another feature is the small size or absence of the canine teeth, or tusks, of the stallion. Shetland Ponies, when young, exhibit the same lateral expansion of the hair at the root of the tail.

The Northern or Dun Type.

Whether the Celtic Pony is a separate race or merely a modified and domesticated Tarpan, there can be no question that the dun type, as typified by the Norwegian Dun Pony, is a distinct race. As no particular breed was specified in the original Linnean description of the domesticated *Equus caballus* as the type of the species, it may perhaps be permissable to regard the Dun Pony of Norway in this light, despite the fact that it has been attempted to give this positio

* Stejneger, *Smithsonian Miscellaneous Collections*, vol. xlviii, p. 4 (1907).

to the Arab*. If this be admitted the Dun Pony should be called *Equus caballus typicus*.

These Ponies are evidently related to the Wild Mongolian Horse, but have a fuller development of the mane and tail, which are wholly black, although specimens may occasionally be seen in England in which the hairs on the root of the tail are shorter than usual. In some cases there is a dark stripe down the back and traces of barring on the legs. The facial portion of the head is longer, and the hoofs are relatively larger than in the Celtic Pony.

This breed may be regarded as probably derived from the Wild Mongolian Horse, and likewise as the main ancestral stock of the ordinary domesticated Horses of North-western Europe. In the skulls of ordinary domesticated Horses the cheek-teeth are, both absolutely and proportionately, much smaller than in the Wild Horse. When Arab blood is presumably absent, there is no trace of a distinct impression in front of the socket for the eye; and in some instances the facial portion of the skull is not markedly bent down on the basal axis. This bending-down of the face on the line of the basal axis may, however, occur in domesticated Horses of all breeds. Skulls exhibiting different degrees of development of this feature are shown in the case in the central arch of the north hall. One of these skulls was obtained from the Roman Fort at Newstead near Melrose, where specimens exhibiting various degrees of bending-down of the face were found (see J. C. Ewart, *Trans. Royal Society Edinburgh*, vol. xlv, 1907).

The relatively smaller head and still smaller cheek-teeth, the shorter ears, the presence of a fore-lock, the larger and pendent mane, the more fully haired tail, and the wider hoofs which distinguish the ordinary Horses of Western Europe from the Wild Horse may be regarded in all probability as due, at any rate to a great extent, to the effects of domestication, although there is also the possibility that they may in some degree be due

* See Stejneger, *op. cit.* p. 470, note. Osborn, on the other hand (*Bull. Amer. Mus.* vol. xxiii, p. 262, 1907), adopts the view here advocated, and uses the name *E. africanus*, Sanson for the Arab; this name is, however, preoccupied by *E. asinus africanus* of Fitzinger.

to the infusion of Arab blood. Much the same may be affirmed with regard to the bending down of the face on the basal axis of the skull.

In a publication recently issued by the Philomathic Society of Alsace-Lorraine * Dr. Max Hilzheimer gives an illustrated description of a remarkable and apparently ancient breed of horse to be met with in the neighbourhood of Schlettstadt, in Upper Alsace, where it is locally known as Riedpferd (Reed Horse) or Pickerle. Small in stature, and of all colours except grey, it frequently shows a dark dorsal stripe, while in one foal the last remnant of a transverse shoulder-stripe was observed, such a vestige being sometimes noticeable in the Wild Mongolian Horse. In its large and clumsy head, with a broad forehead, and a tendency to a concavity in a profile near the base of the nasal bones, the Schlettstadt Horse likewise approaches the wild race, as it also does in its short ears and low withers. On the other hand, in its profuse mane and tail it makes an equally wide departure from the latter, although there is every probability that these features are the result of domestication. Dr. Hilzheimer refers to an account by Elisæus Rösslin, in a work on Alsace-Loraine, published at Strassburg in 1593, of so-called Wild Horses inhabiting the mountains of the Black Forest. These are known to have survived till 1616, when three were shot during a hunt. Although these so-called Wild Horses were probably the descendants of domesticated animals they were doubtless a primitive type, from which, in Dr. Hilzheimer's opinion the Schlettstadt breed may be descended. A further inference is that in the latter we have survivors of the Wild Horse of the Swiss lake-dwellings and of the cave period.

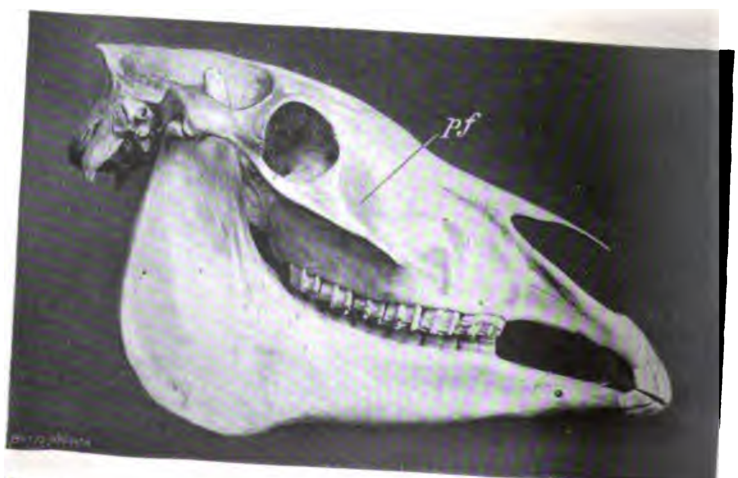
The Southern or Barb Type. The Southern or Barb type (*Equus caballus asiaticus*, or *E. c. libycus*), as represented by Barbs, Arabs, Thoroughbreds, etc., constitutes the fourth and last well-defined group of Horses. In this breed, as we now know it bay with black "points," and not unfrequently a white star or

* *Mitteil. Philom. Ges. Elsass-Lothringen*, vol. iii, p. 368, 1906.

FIG. 17.

SKULL OF THE SHIRE STALLION "BLAISDON CONQUEROR" (No. N. H.

FIG. 18.



SKULL OF AN ARAB MARE, SHOWING THE CHARACTERISTIC SINUOUS PROFILE. (From the specimen, No. N. H. 20, presented by W. Scawen Blunt, Esq.)

[To face page 18.

the forehead may be regarded as the typical colour, although grey is by no means uncommon; and the mane and tail are always long, pendent, and full. The fetlocks of one or more legs are not unfrequently white.

The skull generally, if not invariably, shows a slight depression in front of the socket of the eye (fig. 18, *pf.*), which although now serving as the attachment for the muscle running to the nostril, probably represents the cavity which almost certainly contained a face-gland in the skull of the extinct *Hipparion*. Many of the dark-coloured Horses of Europe have Barb or Arab blood in their veins, this being markedly the case with the Old English Black, or Shire Horse, the skull of which accordingly shows a distinct depression in front of the eye-socket (fig. 17, *pf.*). That the face-gland may well have disappeared in modern Horses is exemplified by Sheep, the domesticated breeds of which possess this structure, although it is lost in the wild American Bighorns. In the latter the place where the gland should be situated is probably occupied by muscle. As two instances are known to the writer in which modern Horses (one an Argentine) have developed functional face-glands, on one or both sides, there is not much doubt that the depression seen in the skulls of Arabs and Thoroughbreds represents the pit for the tear-gland of Antelopes and Deer (fig. 5).

Prof. W. Ridgeway regards bay as the typical colour of the Arab. This is confirmed in some degree by the fact that grey Arabs when aged tend to become flecked with chestnut; and also by the circumstance that some grey Arabs are slate-coloured or mouse-coloured when young.

A considerable number of skulls are placed on exhibition to illustrate the presence of a vestige of the facial gland-cavity in the skulls of Arabs and Thoroughbreds, and its general absence in those of other breeds, except Shires.

The skulls of Arab Horses are further characterised by the long interval between the first upper cheek-tooth and the outermost incisors, as well as by the relatively small size of the upper cheek-teeth, the length of the six cheek-teeth in the skull of "Jerboa" (N.H. 9) being only $6\frac{3}{8}$ inches, while the basal length of the skull itself is $19\frac{3}{8}$ inches, or nearly the same as that of the

Mongolian Wild Horse, in which the length of the tooth-row is $7\frac{1}{2}$ inches. The upper cheek-teeth (fig. 16, C) in the skull of an Arab presented by Mr. Wilfrid Scawen Blunt (N.H. **20**) and likewise remarkable for the extensive folding, or frilling, of the enamel in the centre of the crown; while in both the Arab skulls in the collection the anterior pillar of the upper molars presents an unusually short grinding surface. Both these features are noticeable in the cheek-teeth of the extinct *Equus sivalensis* of India; the skull of that species (N. H. **42**) likewise displaying a vestige of the preorbital depression in a more marked degree than in Arabs and Thoroughbreds. In all these respects the skulls of Arabs and *Equus sivalensis* approximate to that of *Hipparion* (N.H. **49**).

The skulls of Arabs (fig. 18) differ markedly from those of ordinary Horses in the strongly sinuous profile of the face, in the narrow muzzle, and in the great width and depth of the hinder part or "angle" of the lower jaw, as well as in certain minor details; all these features corresponding with the contour of the head of living Arabs. Some Thoroughbreds, such as those of the "King Tom" line, exhibit the characteristic Arab profile very distinctly.

Among Mr. Blunt's Arab stud the presence of a large "wolf-tooth," or rudimentary first premolar is stated to be far from uncommon, at least in the upper jaw, whereas such large teeth are rare in ordinary Horses. Such a tooth was generally, if not invariably, present in both jaws in the extinct *Equus sivalensis* and its allies.

In addition to the features already noticed, Arabs are characterised by the following peculiarities :—

The skull is relatively short, very wide between the eye-sockets, which are high and prominent, thus giving a wide field of vision; while the lower jaw is slender in front, and very deep and wide-set behind. The chest is rounded, and the back and loins are well "ribbed up," due to the presence of only five (in place of six) lumbar or ribless vertebræ. The pelvis—in connection with great speed—is set more nearly horizontal than in other Horses; the croup, or tail-region, is relatively high; and there are only sixteen (in place of eighteen) caudal, or tail, vertebræ. In the

limbs the shaft of the ulna, or small bone of the lower part of the fore-leg, is complete; the cannon-bones are elongated and slender; and the pasterns are long and sloping. Desert-bred Arabs are stated to have denser bones than ordinary Horses.

Despite the fact that a complete ulna has been observed in a skeleton of Grévy's Zebra, the whole of the foregoing characters are regarded by Prof. H. F. Osborn (*Bulletin* of the American Museum of Natural History, vol. xxxiii, pp. 259–263, 1907) to justify the specific separation of the Arab Horse, for which he adopts Sanson's name of *Equus africanus*.* The origin and descent of the Arab are considered by the same observer to be totally different from those of the Northern Horse.

As regards the extent to which the facial part of the skull is bent down on the basal axis, there appears to be some amount of variation among Arabs and Thoroughbreds; but the feature is always developed in a considerable degree. It also occurs in the skull of the extinct *Equus sivalensis* as is shown by a cast (N.H. **42**) in the north side of the table-case.

This marked bending-down of the face in *Equus sivalensis*, coupled with the presence of a distinct remnant of the preorbital face-pit in the skull and the above-mentioned characters of the dentition, indicates the essential distinction of that species from the Mongolian Wild Horse, which, as already mentioned, is regarded as the survivor of the ancestral type which gave rise to the ordinary Horses of North-western Europe. And since several of the features characteristic of Arabs and Thoroughbreds are met with in *Equus sivalensis*, there seems a probability that the latter (or some closely allied race) may have been the ancestral stock from which Barbs, Arabs, and Thoroughbreds are derived. At any rate, this theory seems to afford a better working explanation of the facts of the case (so far as they are at present known) than any other hitherto suggested. If the Arab Horse should ever be proved to be descended from a species distinct from the one which gave rise to the Wild Horse of Mongolia, it will, of course, have to bear a name other than *Equus caballus*.

* See note page 17.

Specimens of Arabs and Thoroughbreds. Limitations of space, apart from all other considerations, prevent the exhibition of complete specimens of the larger breeds of Horses; and the exhibited series is therefore, in the main, limited to heads, skulls, limb-bones, and minature models, supplemented by pictures. Arabs are, at present, represented by a statuette of "Zenghis Khan" (N.H. **124**), modelled in Hungary, and two skulls of mares. One of the skulls (N.H. **20**, fig. 18) is the gift of Mr. W. Scawen Blunt, the well-known breeder of Arabs, while the other "Jerboa" (N.H. **9**) was presented by Mr. H. T. Sills of Cape Colony. Both are mares and show the characteristic curved facial contour already referred to, which reappears in some Thoroughbreds, as in the skull of "Royal Hampton" (N.H. **11**), shown alongside that of Jerboa, and also in that of "Corrie Roy" (N.H. **10**). "Royal Hampton," it may be added, was a descendant of "King Tom" (see pedigree). A photograph of the "Darley Arabian," taken from the original picture at Aldby Park, York, and presented by Miss F. M. Darley, has been here reproduced (fig. 15) as a good illustration of the Arab type; this particular Horse having taken a considerable share in the production of the modern Thoroughbred.

From the "Darley Arabian" was descended the famous Thoroughbred Stallion "Eclipse," of whose skull and skeleton photographs (N.H. **128**) are exhibited on the back of the case containing the skeletons of the Man and the Horse. The skeleton of "Eclipse" is preserved at the Royal College of Veterinary Surgeons in Red Lion Square, Holborn. "Eclipse" was bred by the Duke of Cumberland in 1764 (the year of the great eclipse of the sun), and died in 1789. He was a chestnut, with a white blaze on the face and one white foot. He was never beaten, and during his two years turf-career was the winner of eighteen races. "Eclipse" was sired by "Marske," a great grandson of the "Darley Arabian."

Of Thoroughbreds represented in the collection by skulls, or skulls and skeletons, by far the most celebrated is the stallion "Stockwell," who was foaled in 1849, and died in 1876. He was winner of the St. Leger in 1852. The skull (N.H. **15**) and

skeleton was presented by Mr. J. C. Naylor in 1876. The following is the pedigree of this Racehorse for four generations:—

STOCKWELL, 1849	The Baron, 1842	Birdcatcher, 1833	Sir Hercules, 1826
			Guiccioli, 1826
		Echidna, 1837	Economist, 1826
			Miss Pratt, 1825
	Pocahontas, 1837	Glencoe, 1833	Sultan, 1816
			Trampoline, 1825
		Marpessa, 1830	Muley, 1810
			Clare, 1824

"Stockwell" had a large amount of the blood of "Eclipse" in his veins, and also a strain of that of "Herod."

Another celebrated Thoroughbred stallion is "Ormonde," who was foaled in 1884, and died in 1904. Bred by the First Duke of Westminster, he was winner of the Derby, the St. Leger, and the Two Thousand Guineas in 1886, and was an unbeaten Horse. Ormonde is generally regarded as the best racer of the 19th century. The skull (N.H. **13**) and part of the skeleton were presented by Mr. A. B. Macdonough in 1905. The pedigree of this stallion, to the fourth generation, is as follows:—

ORMONDE, 1884	Bend-Or, 1877	Doncaster, 1870	Stockwell, 1849
			Marigold, 1860
		Rouge Rose, 1865	Thormanby, 1857
			Ellen Horne, 1844
	Lily Agnes, 1871	Macaroni, 1860	Sweetmeat, 1842
			Jocose, 1843
		Polly Agnes, 1865	The Cure, 1841
			Miss Agnes, 1850

The skull of the Thoroughbred stallion, "Bend-Or" (N.H. **14**) the sire of "Ormonde," was presented by the Duke of Westminster in 1903. "Bend-Or" was foaled in 1877 and died in 1903.

He was winner of the Derby in 1880. His pedigree is as follows:—

BEND-OR, 1877	Doncaster, 1870	Stockwell, 1849	The Baron, 1842
			Pocahontas, 1837
		Marigold, 1860	Teddington, 1848
			Sister to Singapore, 1852
	Rouge Rose, 1865	Thormanby, 1857	Windhound, 1850
			Alice Hawthorn, 1838
		Ellen Horne, 1844	Redshank, 1833
			Delhi, 1838

The Collection also contains the skull of "Royal Hampton," a Thoroughbred stallion foaled in 1882, who died in 1906. He was winner of the National Breeder's Produce Stakes at Sandown Park in 1884, and of the City and Suburban Handicap, 1886. "Royal Hampton" was owned by Sir J. Blundell Maple, and the skull (N.H. **11**) was presented by Mrs. Ballard (Lady Maple) in 1906.

The following is the pedigree of this well-known Horse:—

ROYAL HAMPTON, 1882	Hampton 1872	Lord Clifden, 1860	Newminster, 1848
			The Slave, 1852
		Lady Langden, 1868	Kettledrum, 1858
			Haricot, 1847
	Princess, 1872	King Tom, 1851	Harkaway, 1834
			Pocahontas, 1837
		Mrs. Lincoln, 1866	North Lincoln, 1856
			King Alfred's Dam, 185

The skull, in addition to showing the faint trace of a preorbital depression common to most Thoroughbreds, is noteworthy for retaining the characteristic sinuous Arab profile, which is always a character of Horses descended from "King Tom."

Another Thoroughbred stallion of which the skull (N.H. **12**) is exhibited is "Donovan," who was foaled in 1886 and died in February, 1905. He ran 21 races in 1888 and 1889, out of

which he won 18. The skull was presented by the Duke of Portland in 1905. Donovan's pedigree is given below:—

DONOVAN, 1886	Galopin, 1872	Vedette, 1854	Voltigeur, 1847
			Daughter of, 1849
		Flying Dutchess, 1853	Flying Dutchman, 1846
			Merope, 1843
	Mowerina, 1876	Scottish Chief, 1861	Lord of the Isles, 1852
			Miss Ann, 1846
		Stockings, 1863	Stockwell, 1849
			Go-ahead, 1853

To show the characters of the Thoroughbred head, that of "Corrie Roy," a mare foaled in 1878, who died in 1901, is exhibited. She was the winner of the St. Ebor Handicap and the Manchester November Handicap, 1883. The head (N.H. **10**) was presented by Sir J. Blundell Maple, her owner, in 1901. The legs of the same mare are also exhibited, as a contrast to those of a Shire Cart-Horse.

Passing on to statuettes of Thoroughbreds, the first for mention is that of the celebrated English stallion "Persimmon" (N.H. **118**), owned by H.M. the King. "Persimmon" was foaled in 1893; his sire being "St. Simon," and his dam "Perdita II." He was winner of the Derby and the St. Leger in 1896, and of the Ascot Gold Cup and Eclipse Stakes in 1897. The statuette was presented by H.R.H. the Prince of Wales in 1905. Persimmon's pedigree is as follows:—

PERSIMMON, 1893	St. Simon, 1881	Galopin, 1872	Vedette, 1854
			Flying Duchess, 1853
		St. Angela, 1865	King Tom, 1851
			Adeline, 1851
	Perdita II, 1881	Hampton, 1872	Lord Clifden, 1860
			Lady Langden, 1868
		Hermione, 1875	Young Melbourne, 1855
			La Belle Heléne, 1866

Another statuette (N.H. **119**) is that of the Thoroughbred chestnut stallion "Zinfandel," a son of "Persimmon" out of "Medora." He was foaled May 6th, 1900; and was winner of the Ascot Gold Vase, the Manchester Cup, and the Brighton Cup in 1903, and of the Jockey Club Cup at the Newmarket Houghton Meeting in 1904. The statuette was presented by the owner, Lord Howard de Walden, in 1905.

Statuettes of several half-bred stallions and mares are also shown.

In a case alongside one of the pillars on the north side of the hall are exhibited the bones of the left limbs of the Thoroughbred "Stockwell" (N.H. **97, 98**) alongside those of the Shire Horse "Blaisdon Conqueror" (N.H. **99, 100**). In the following table the measurements of the limb-bones of "Stockwell" are contrasted with those of a Cart-Horse:—

		Race-Horse.	*Cart-Horse.*
Fore-Limb.	Humerus	$13\frac{1}{2}$ in.	$14\frac{3}{4}$ in.
	Radius	15	$14\frac{1}{2}$
	Metacarpus	$10\frac{1}{2}$	$10\frac{1}{4}$
	1st Phalange	4	$3\frac{3}{4}$
Hind-Limb.	Femur	17	$18\frac{1}{4}$
	Tibia	15	15
	Metatarsus	$12\frac{1}{2}$	$11\frac{3}{4}$
	1st Phalange	$3\frac{3}{4}$	4

From this it will be seen that while the upper segment of the limbs (humerus and femur) is shorter in the Race-Horse than in the Cart-Horse, the reverse is the case with most of the other bones. This greater proportionate length of the lower part of the leg probably gives greater speed in the Race-Horse; but a larger series of specimens is necessary before it can be definitely affirmed that these proportions are constant.

Specimens of the Shire Horse. The Shire Horse, so-called from being chiefly bred in the Midland Counties, and the most powerful animal of its kind, is the descendant of the old English Great Horse, or Black Horse, which was used as a war-horse when armour was worn, and was capable of carrying 32 stone. By Queen Elizabeth's time it was relegated to the duties of a coach-

horse, and is now employed only as a draught-horse. In colour it is generally black, often with a white star on the forehead and white fetlocks; the tail and mane are profuse, and the legs very hairy. Although originally English, the Shire Horse was in early days crossed with Neapolitan and Flanders Horses (which have Barb blood in their veins) if not with the Barb itself, and it has been suggested that the colour of the breed is largely due to Barb ancestry. Evidence of such a crossing appears to be afforded by the presence of a distinct depression in front of the eye-socket in the skull of this breed (fig. 17); such a depression being, as already mentioned, characteristic of Barbs, Arabs, and Thoroughbreds. In the limb-bones the rudimentary lateral digits are very strongly developed (see page 10).

Among specimens of this breed exhibited in the North Hall is the skull (N.H. **8**, fig. 17) of "Blaisdon Conqueror." This famous horse, whose sire was "Hitchin Conqueror" and dam "Welcome," was foaled in 1894, and died in October, 1904. He stood 17 hands, 2 inches in height, and was placed in the first class and won many cups and other prizes at the Shire Horse Show at Islington in 1899, 1902, and 1904. His number was 15989 in the Shire Horse Stud-book. The skull and limb-bones were presented by the breeder and owner, Mr. P. Stubs, in 1905. The limbs of the left side are exhibited, as mentioned above, alongside those of the Thoroughbred "Stockwell."

In the same year as the last the Museum also received the skull of another Shire Stallion, "Prince William" (N.H. **22**), who was foaled in 1883, and died in 1905. His Stud-book number was 3956, and his breeder Mr. W. H. Potter. The skull was presented by Lady Wantage in 1905. Both in this and the last specimen the vestige of the preorbital depression is very clearly displayed. The cannon-bones of "Prince William" (fig. 7) are exhibited in one of the table-cases, to show the great development of the splint-bones characteristic of this breed. For remarks concerning these and other specimens of the feet of Shire Horses see page 10.

The large case in the central arch on the northern side of the hall contains the mounted head (N.H. **5**) and skull (N.H. **23**) of the famous Shire Mare "Starlight," presented in 1906 by Mrs. Crisp, the widow of the owner, Mr. F. Crisp, of Long

Stanton, Cambridgeshire. This mare was foaled in 1882 and die in 1899, her sire being "Sir Colin" and her dam "Williamson Mettle." She was winner of a large number of first an champion prizes at various shows, and likewise took the gol medal at the London Shire Horse Show in 1890, 1891, an 1892.

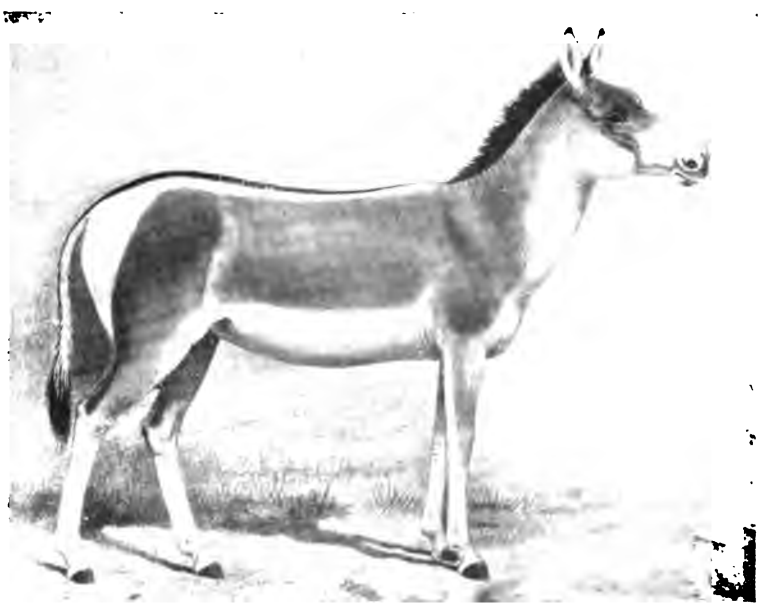
The Khatiawar Pony. Great interest attaches to a mounted specimen o a Dun Khatiawar Pony (N.H. 4) from Ahmednagar, India, exhibited in the case in the central arc on the north side of the hall, on account of the presence of a dark dorsal stripe and of zebra-like markings on the legs, as well as of a trace of a shoulder-stripe. The specimen was presented by the Superintendant of the Veterinary Department, Bombay, in 1903. Ponies of this breed are referred to by Darwin on account of dun-coloured specimens (like the one exhibited) so frequently showing dark barrings on the legs. The breed has been regarded as mainly derived from the Arab, and very probably it may have been crossed with the latter. In general colouring, and especially in the presence of a dark stripe down the back, as well as in the large size of the head and relatively low setting-on of the tail, which is sparsely haired at the root, where some of the hairs are tan-coloured, dun-coloured individuals are, however, much more like the Dun Norwegian Pony and the Wild Mongolian Horse. Arabs apparently never show a dark dorsal streak, which is essentially a character of the dun northern type. Unfortunately no specimen of the skull is at present available for a comparison of the cheek-teeth with those of the Wild Mongolian Horse.

The Chigetai and Kiang. The nearest living relative of the Horse is the Central Asian species represented by the Chigetai of the Mongols and the Kiang of the Ladakis; these being apparently local races of a single species, *Equus hemionus*. These animals are commonly termed Wild Asses, although they have no near relationship to the true Wild Asses (*Equus asinus*) of Africa. Like all the undermentioned members of the family, the species differs from the Horse by the absence of callosities on the hind-limbs, and the large size and less warty nature of the front callosities; as well as by the tail having long hairs only near the tip.

Fig. 19.

The Kiang.
(Lydekker, *Proc. Zool. Soc.* 1904, vol. i, pl. xxviii.)

Fig. 20.



The Kobdo Onager.
(Lydekker. *Novitates Zoologicæ*. vol. xl. pl. xvii.)

The Chigetai-Kiang is a native of Mongolia and Turkestan, ranging northwards to Transbaikalia and westwards to Transcaspia. In size it is large, the height at the shoulder reaching to 12¾ hands. The ears (in comparison with those of *E. asinus*) are relatively small and horselike; and the hoofs are large and broad, the width of the front pair markedly exceeding that of the hind ones. The tail-tuft is large, and a slight rudiment of a forelock is present. A relatively narrow dark dorsal stripe reaching the tail-tuft, and (in most cases at any rate) not bordered with white, is present; but there is no shoulder-stripe, or dark barrings on the limbs, although there is a dark ring immediately above the hoofs. The general colour of the upper-parts, in the summer coat, varies from bright rufous chestnut (with a more or less marked tinge of greyish fawn on the neck) to reddish sandy; but the muzzle, the inside of the ear, the throat, under-parts, the inner side of the legs, and a streak on the buttocks, are pure white or buffish white. In the long winter coat the general colour is apparently not distinctly grey, although greyish in the typical form. The cry is a "shrieking bray."

The Kiang (*Equus hemionus kiang*, fig. 19), of Ladak and Tibet, as may be seen by comparing the mounted specimen (M. **1013**) in the lower mammal gallery of the Museum with the example of the Somali Wild Ass standing in the same case, is characterised by the great width of the hoofs, more especially the front pair. In this respect it approaches *Equus caballus* (as it does in its relatively small ears and its colour), and differs widely from *E. asinus*. The Ghor-khar and Onagers, on the other hand, have small and narrow hoofs, like those of the last-named species.

The Kiang is by far the reddest of all the Asiatic Wild Asses, and apparently becomes but little greyer in winter. In addition to its small ears, broad hoofs, narrow dorsal stripe, and general colour, it is affiliated to *Equus caballus* (inclusive of the Wild Horse of Mongolia, *E. c. przevalskii*) by the nature of its cry, which is to a great extent intermediate between that of the Horse and the Ass; although there is a certain amount of discrepancy between the description of the Kiang's call given by different observers. General Cunningham, for instance, in his work on "Ladak," calls it a neigh, and other observers have described it as

much like neighing as braying; but Moorcroft and Gene[ral] Strachey described it as more like braying than neighing, t[he] latter traveller observing that "my impression of the voice of t[he] Kiang is that it is a shrieking bray, not like that of the Comm[on] Ass, but still a real bray, and not a neigh." It is perfect[ly] distinct from the bray of *E. asinus*, and also differs from the c[all] of one of the races of *E. onager*.

A sinuous profile, a narrow chocolate dorsal stripe, and che[st]nut body-colour, with pure white on the muzzle, shoulder, unde[r] parts and inner sides of the limbs are distinctive features of t[he] Kiang.

The typical race of the species (*Equus hemionus typicus*) inhabiting Mongolia and Turkestan, is termed Chigetai by t[he] Mongols and Kulan by the Tatars and Kirghiz. It is at prese[nt] not shown in the collection. In its make and actions—especiall[y] of starting when alarmed with the head so elevated that the plan[e] of the face is almost horizontal—as well as in the general type o[f] colouring, the Chigetai agrees essentially with the Kiang. Both i[n] the winter and summer coat it lacks, however, the distinctly rufous chestnut tint characteristic of the latter, while it is also characterise[d] by the less marked contrast between the light and dark areas o[f] the coat; the light areas on the muzzle, buttocks, legs, under parts, etc., being "isabella-coloured" instead of white, and thu[s] less differentiated from the fawn of the rest of the body; whil[e] the light areas on the neck and shoulder are smaller. The genera[l] colour is pale sandy fawn, with the tips of the ears, mane, dorsal stripe (which is continued down the tail) brown; and there seems little difference in this respect between the summer and the winter coat.

The Onager or Ghor-khar. The next Asiatic representative of the family is the Onager or Ghor-khar (*Equus onager*) of the desert districts of Western and W. Central Asia and North-Western India, where it is represented by several local races. In size it is considerably less than *E. hemionus*, the minimum recorded height being 11 and the maximum 11½ hands. The ears are apparently much the same as in the latter; and the hoofs are narrow and Ass-like; the front pair being but little wider than the hind pair. The profile of the face is either nearly straight

or markedly sinuous ; the tail-tuft is moderate, and the dark dorsal stripe is very broad, in some cases stopping short of the tail-tuft, and bordered, at least posteriorly, by a band of white or whitish, which joins the white on the buttocks and the back of the thighs. The upper–parts, in the summer coat, are usually some shade of pale reddish fawn or sandy (isabelline); while the light areas, which vary from pure white to whity brown, are much the same in extent as those of *E. hemionus*, but extend more on to the buttocks, and thence along the sides of the dorsal stripe, and in some cases occupy more of the body and head. In winter the long and rough coat becomes more or less decidedly grey, and in one race is distinctly mouse-grey with sharply defined white areas.

The cry of the Indian Ghor-khar is a "shrieking bray," and therefore not unlike that of the Kiang; but in the case of the Syrian Onager, and probably also in that of the true Onager, it is stated to be more like that of the Ass, to the wild forms of which the species approximates in its narrow hoofs, broad dorsal stripe, small tail-tuft, and grey colour of the winter coat in at least one local race.

The Onager appears to be represented in a Prehistoric sketch incised on a fragment of Reindeer antler discovered in the cave of Kesslerloch, Schaffhausen.

No specimen of this species is at present exhibited.

Of the local races of this species, the first is the Indian Ghor-khar (*Equus onager indicus*) of the deserts of Sind, Kach, and Baluchistan. The height at the shoulder reaches 11½ hands, and the profile of the face is straight. The general colour of the upper-parts is sandy in summer, with the light band on each side of the dorsal stripe narrow, ill-defined, and whitey-brown in colour, and the white on the rump not pure. The broad dorsal stripe does not reach the tail-tuft.

The second race is the Kobdo Onager (*Equus onager castaneus*, fig. 20), from Kirghis-Nor, Kobdo, in Western Mongolia, characterised by the straight profile of the face, the rufous isabella hue of the summer coat, the full mouse-grey colour of the winter coat, the large amount of pure white on the buttocks, and the distinctness of the pure white band on each side of the dorsal stripe, which extends quite down to the tail-tuft. The broad chocolate-coloured dorsal

stripe reaches to the tail-tuft, and is bordered on each side by a wide pure white band, expanding to join a large white blaze on the buttocks and the hind surface of the thighs. The other light areas are the muzzle, throat, chest, under-parts, and inner sides and lower portions of the limbs; the inside of the ears being greyish white, while elsewhere the general colour in the winter coat is grey-fawn, with a faint tinge of sandy rufous in places. In the summer coat the dark areas are bright sandy fawn or rufous isabella, with a white rump-patch, muzzle, and under-parts; the sides of the face and throat, as well as the outer side of the lower part of the legs, being pale isabella, as is also an indistinct line on the flank in front of the thigh. In no other Onager with a uniform body-colour is there such a large white rump-patch.

The Syrian Onager (*Equus onager hemippus*), of the deserts between Bagdad and Palmyra, Mesopotamia, and North Arabia, is reddish isabella-colour above, with the dorsal stripe not extending to the root of the tail, of which the tip is moderately haired; the throat, the under-parts, a broad band on each side of the dorsal stripe, the hind border of the thigh, and an oblique band above the flanks are silver-white. So far as is known, the profile is sinuous, and the ears and head are relatively small.

The fourth race is the Persian Onager (*Equus onager typicus*) of Northern Persia, characteristic by the predominance of the white over the fawn-coloured areas of the head and body. The general colour is silvery white; the dorsal stripe does not reach the tail-tuft; and the head, the sides of the neck, a small, ill-defined band in front of the shoulder, a larger quadrangular patch on the sides of the body, the middle of the hip, and the upper part of the limbs are isabella-colour. The profile is remarkably convex, and the ears are relatively small. This race is the lightest in colour of all the Asiatic Wild Asses, the fawn-coloured area being reduced to large isolated patches.

Grevy's Zebra. The species known as Grévy's Zebra (*Equus grevyi*, M. **1025**, fig. 21), which inhabits Somaliland and Abyssinia, and is thus the most northerly of the striped group, is markedly different in many respects from the true Zebras and Quaggas. The arrangement of the striping on the hind-quarters is altogether unique; the callosities on the fore-legs are as

Fig. 21.

Grèvy's Zebra.

Fig. 22.

The Quagga.
(From a photograph of a living specimen.)

[To face page 32.

small as in the Horse; and, as in that species, the mane extends on to the withers, and the tail-tuft is large and full. Furthermore, the large, broad, and thickly-haired ears are quite different from those of all other members of the family, which are narrow and pointed. The large size of the ears and the narrowness of the stripes appear to be adaptations to a life partially spent in thick scrub, as is shown in a photograph by Lord Delamere, exhibited in the lower mammal gallery. A fine male specimen of the species, presented by Gen. Sir A. H. Fitzroy Paget, is shown in the large Zebra case in the same gallery.

The colour-pattern of Grévy's Zebra may be described as follows:—The dark (dark brown or black) and light stripes on the body, head, and limbs are for the most part very narrow, widening out only on the lower jaw, on the neck, and on the lower part of the thigh. On the flank none of the stripes bend backwards and upwards to extend on to the hind-quarters, the upper portion of which is marked with vertical stripes arranged concentrically round the root of the tail. The dorsal stripe is very broad, especially near the middle of the back; and there are no transverse stripes on the under-parts. The stripes on the nose practically stop short of the nostril-patches, and the nose itself is greyish.

It will be evident from this description that in the present species the stripes on the rump have their concavity directed upwards, whereas in the next species the convexity is upwards.

Two races, or subspecies, of Grévy's Zebra have been named.

The Quagga. The extinct South African Quagga (*Equus quagga*, M. **1017**, fig. 22), together with the following striped species, has the callosities on the front legs larger than in Grévy's Zebra, and the stripes broader. In this group, whenever the hind-quarters are striped, the stripes are obliquely longitudinal, with the uppermost ones arising from the posterior region of the body, where their upper extremities are bent backwards towards the root of the tail in such a manner that there is no concentric arrangement round the latter. The muzzle is dark, and usually black, and the stripes on the nose are continuous with the dark patches round the nostrils. The ears are narrow.

In the Quagga, which was confined to the plains south of the Orange River, the ears are comparatively small, the front hoofs are

rather large, and full striping is developed only on the head, neck, and fore-quarters, although in some specimens spots on the flanks indicate disappearing stripes further back. The stripes do not extend across the lower surface of the body. The general colour appears to have been yellowish red, or chestnut.

The species is represented in the collection by the mounted skin and the skeleton of a male formerly living in the Zoological Gardens in Regent's Park. That animal, which was one of the last survivors of the species, was presented to the Zoological Society by Sir George Grey, K.C.B. in 1858, and lived in the Menagerie in the Regent's Park till June 1864.

The skin is exhibited in case No. **38**, in the lower mammal gallery, and the skull on the opposite side of the same case. This skull shows a vestige of a cavity in front of the eye-socket.

It is very probable that several local races of the Quagga formerly existed, and four of these have already been recognized and named. In the case of an extinct species it is, however, very difficult to arrive at any satisfactory conclusion with regard to its local forms.

The following observations in regard to the colouring of Quaggas and Zebras appeared in *Nature* for 1903.

Colouring of Quaggas and Zebras. The testimony of observers in the field has established the truth that the coloration of the coat renders a Zebra invisible under three conditions, namely, at a distance on the open plain in midday, at close quarters in the dusk and on moonlit nights, and in the cover afforded by thickets. One reason for this is the blending of the white stripes with the shafts of light sifted through the foliage and branches and reflected by the leaves of the trees, so that in an uncertain light or at long range these mutually counteract each other and fuse to a uniform grey. It is also probable that the alternate arrangement of the black and white bars contributes something to the effect produced, by imparting a blurred appearance to the body and destroying the evenness of its surface owing to the difference in light-reflecting power between hairs of these hues. Again, the extension of the stripes to the edge of the body and legs breaks up the continuity of the outline, this being apparently the reason for the alteration in their direction on the hind-quarters and limbs, so that, except

on the forehead, the whole animal is barred transversely with reference to the lines of its spine and limbs.

It is also stated that the Asses of the deserts of North-East Africa are perfectly adapted to their surroundings in colour, and no one can doubt that the assimilation is equally perfect in the case of the Kiang and the Wild Horse of Central Asia. In the matter of colouring the Kiang recalls the Quagga, despite a difference in the deepness of the brown pervading the upper-parts in the two species. Notwithstanding this difference, there seems no question that the explanation of the significance of the colouring of the Kiang applies with equal truth to the Quagga. This explanation is the action of light and shade.

In the Kiang it will be noticed that the upper-parts, on which the light falls, are of a rich ruddy hue, darker than ordinary sand, while the muzzle, the lower side of the head, the throat and under-parts are creamy white; an arrangement which must render it practically invisible when standing in the desert at a distance. The white limbs and backs of the thighs may be explained as follows:—When a Kiang lies down, with the hind-quarters depressed, the fore-legs folded and the hind-legs tucked in close to the body, the white on the back of the thighs is brought into line with that of the belly, and a continuous expanse of white, obliterating the shadow, extends all along the underside from the knee to the root of the tail. The same is the case with the Quagga and the under-mentioned Bonte-Quagga; and it indicates, in the case of the latter, the meaning of the change in pattern presented by the different local races as we pass from Somaliland southwards into Cape Colony. In correlation with the adoption of a life in the open, a new method of concealment by means of shadow counteraction was required, and was perfected by the toning down of the stripes on the upper side and the suppression of those on the hind-quarters, legs, and under-parts.

Burchell's Zebra, or Bonte-Quagga. Although the typical southern race of the exceedingly variable species known as *Equus burchelli* is commonly called Burchell's Zebra, it is much better designated by its Boer title of Bonte-Quagga (*i. e.* Painted Quagga), since this obviates the use of such incon-

venient names as "Chapman's Burchell's Zebra." The species very closely allied to the Quagga, from which perhaps it is n really separable; but the stripes are always well developed on t hind-quarters, where they present the characters mentioned und the heading of that animal. The species displays remarkab variation in colouring and markings as we proceed from south north; the typical southern race (fig. 23) having dark brow stripes with intervening brown "shadow-stripes" on an orang ground, and unstriped legs, whereas in the northern race (fig. 2 the stripes, which are black on a white ground, extend down the hoofs, and have no intervening shadow-stripes.

In all cases the upper extremities of some five or six stripes o the hind half of the body are bent backwards parallel to the dors stripe; while the light area between these body-stripes and th dorsal stripe is continued to the root of the tail, and is not crosse by transverse bars, but traversed longitudinally by the backwar extension of at least one of the body-stripes.

The typical Burchell's Bonte-Quagga, or Burchell's Zebra (*Equu burchelli typicus*, M. **1018**, fig. 23), now nearly, if not completel extinct as a wild animal, formerly inhabited British Bechuanalan and some of the adjacent districts in enormous droves. In this rac the ground-colour is orange, and the shadow-stripes on the hind quarters are very strongly marked, and narrower than the mai stripes, which are themselves broader than the light interspace containing the shadow-stripes. The hind-quarters have only few short stripes below the long stripe running to the root of th tail; the body-stripes stop short on the sides of the under-parts so as to be widely separated from the longitudinal ventral stripe and, with the occasional exception of a few on the knees and hocks the legs are devoid of stripes, as are usually the sides of the tail

This race is represented by a specimen from the Orange Rive Colony, the gift of the Hon. Walter Rothschild.

The next race (and only some of the more important ones ar here referred to) is the Damaraland Bonte-Quagga (*E. burchelli antiquorum*) in which stripes are developed above the knees an hocks, but none (or very few) below. It is unrepresented in the exhibited series.

With the Zulu Bonte-Quagga (*E. burchelli wahlbergi*) w

FIG. 23.

THE BONTE-QUAGGA OR BURCHELL'S ZEBRA. Typical Race.
(Lyon, *Proc. U. S. Nat. Mus.*, vol. xxxii, pl. i.)

FIG. 24.

GRANT'S BONTE-QUAGGA.
(Sclater, *Proc. Zool. Soc.*, 1901, vol. ii, pl. xxix.)

[*To face page* 36.

reach a race in which, like all those which follow, the body-stripes meet the ventral stripe inferiorly, while the legs are more or less fully striped. In this particular race the shadow-stripes on the hind-quarters are strongly developed, and not much narrower than the main stripes, which are narrower than the intervening spaces; and the fetlocks and pasterns are devoid of stripes or spots. This race is represented in the collection by a specimen (M. **1022**) purchased in 1846 from Mr. Wahlberg, after whom it is named. In Chapman's Bonte-Quagga (*E. burchelli chapmani*) the shadow-stripes have become faint and narrow, the legs are marked to the hoofs, but the stripes on their lower portions tend to break up into spots, and the inferior part of the pasterns is not wholly black. This race inhabits the country between Damaraland and Matabililand; it is represented in the exhibited collection only by a photograph. The last representative of the species in which shadow-stripes are distinctly developed is the Mashona Bonte-Quagga (*E. burchelli selousi*), of which an example shot by Mr. F. C. Selous (M. **1023**) is exhibited in the large case in the Horse bay in the lower mammal gallery. It differs from the last in that the striping of the legs is complete right down to the hoofs; the pasterns being striped on both sides, and their lower part, owing to the fusion of several stripes, wholly black. The sides of the tail are also striped.

All the foregoing races inhabit the country south of the Zambesi, but they have a representative north of that river in the Kilimanjaro Bonte-Quagga (*E. burchelli boehmi*, M. **1021**), which is nearly allied to *E. b. selousi*, but retains scarcely any trace of shadow-stripes, while the stripes on the pasterns remain distinct from one another. The shadow-stripes are frequently visible only on the hind-quarters. The specimen exhibited was presented by the Hon. Walter Rothschild.

The most northern members of the species are Crawshay's Bonte-Quagga (*E. burchelli crawshayi*) of British Central Africa, or Nyasaland, represented by a head (M. **1019**) given by Lt.-Col. Manning in 1901, and Grant's Bonte-Quagga (*E. burchelli granti*) M. **1020**, fig. 24), ranging from British East Africa (Masailand) to Southern Abyssinia, of which a complete specimen from Lake Baringo is shown. In both races the shadow-stripes have

completely disappeared, and the principal stripes on the hind-quarters are not narrower (and may be broader) than the intervening spaces, which are white. In *E. burchelli crawshayi* the stripes are relatively narrow and deep black in colour, while the nostril-patches are yellowish brown, or tan, and the pasterns are coloured like those of *E. burchelli selousi*. In *E. burchelli granti*, on the other hand, the stripes are broader and apparently less completely black, while the nostril-patches are black, and the stripes on nearly the whole of the pasterns have fused into a continuous black patch.

The difference between *E. burchelli granti* and *E. burchelli typicus*, in the matter of colour and pattern, is much greater than that between the latter and *E. quagga*.

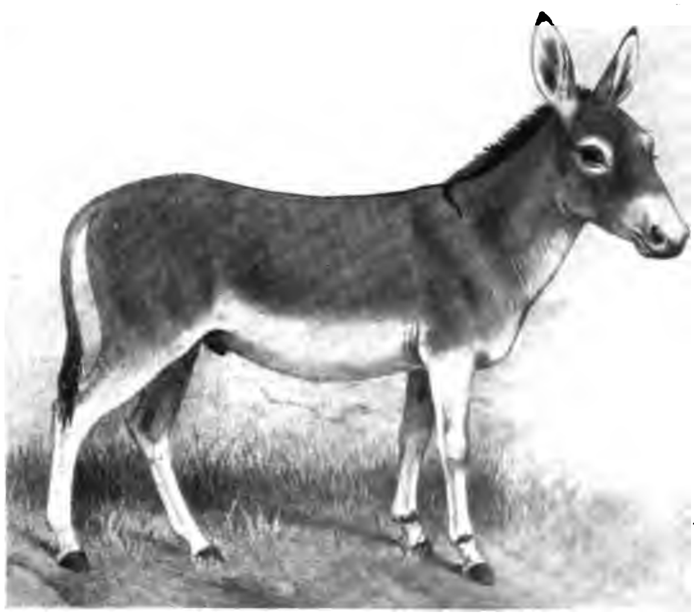
The Zebra. The true Zebra (*Equus zebra*, M. **1024**, fig. 25), often termed the Mountain Zebra, in order to distinguish it from the Bonte-Quagga or Burchell's Zebra of the plains, is a very different animal to the last, and much more nearly related to the Ass. In the first place, the direction of the hairs along the spine between the withers and the rump is reversed, so that they are inclined forwards instead of backwards. Secondly, the ears are longer, the hoofs are narrower, and the tail-tuft is more scanty. Thirdly, all the body-stripes, with the exception of two passing on to the rump and hind-quarters, are continued upwards to meet the longitudinal dorsal stripe which they cut at right angles; while the area on the rump between the dorsal stripe and the uppermost haunch-stripe running to the root of the tail, in place of being longitudinally striped; is marked by a series of transverse bars forming a "gridiron-pattern." The body-stripes stop short on the sides, so as to be far removed from the ventral stripe.

The Zebra was formerly found in all the mountain-ranges of Cape Colony, but is now restricted to the Cradock district, where it is protected by law. It was from this locality that the specimen exhibited in the Lower Mammal Gallery was obtained. The species is represented in Angola by Penrice's Zebra (*E. zebra penricei*), and in Damaraland by Hartmann's Zebra (*E. z. hartmannæ*), which are, however, perhaps not separable from one another.

Fig. 25.

The Mountain Zebra.

Fig. 26.



The Nubian Wild Ass.
(Lydekker, *Novitates Zoologicæ*, vol. xi, pl. xx.)

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Other Zebras. In the *Proceedings* of the Zoological Society of London for 1904 (p. 181) Prof. J. C. Ewart described a Zebra, probably from the district between the upper part of the Tana River and Lake Rudolf, resembling *E. zebra* in height, the form and size of the head, ears, and muzzle, in the characters of the mane, tail, and hoofs, and also in the gridiron-pattern of the rump-stripes. It differs from that species in the backward inclination of the hairs of the broad dorsal stripe, and in certain details of striping and colour; the ground-colour being rich cream. The name of Ward's Zebra was suggested for this animal.

In the same Journal for 1906 (p. 691) the Hon. Walter Rothschild described, as *Equus annectans*, a Zebra from N. E. Rhodesia distinguished by its narrow white stripes and broad black stripes extending from behind the ears to the root of the tail. The longitudinal stripes, which extend from the root of the tail more towards the shoulder than in any other Zebra, are united to the transverse stripes, instead of being broken, as in most races of the Bonte-Quagga. In the absence of chestnut on the face it resembles *E. burchelli selousi*. The head, limbs, and tail are evenly marked with narrow white stripes on a black ground; and the ears are also strongly striped. The skull is stated to be intermediate between that of the Zebra and that of the Bonte-Quagga. Another Zebra, from German East Africa, has been named by Dr. P. Matschie (*Weidwerk in Wort und Bild*, 1906, p. 236) as *Hippotigris muansæ*.

The Ass. The last of the living representatives of the Horse family is the Ass (*Equus asinus*), which in a domesticated condition, is found almost throughout the habitable world, and as a wild animal in North-eastern Africa, south of the Tropic, from Upper Nubia to Somaliland. It is the only Wild Ass found within the tropics, and the only one which is completely grey at all seasons of the year. The typical form of the species appears to be the Domesticated Ass of North-western Europe.

The bodily size in the wild state is medium or large, the height at the shoulder ranging from 3 ft. 9½ in. to 4 ft. 1 in. The ears are very long, the hoofs small and narrow, with no marked

superiority in the size of the front pair; while the tail-tuft is moderate, and there is no trace of a fore-lock. The dark dorsal stripe is narrow, and in some cases discontinuous, not reaching the tail-tuft, and being without white borders. Either a shoulder-stripe or dark barrings on the legs, or both together (in the domesticated race), are present, and there is no dark ring above the hoofs. There is a distinct white ring round the eye, but no white on the buttocks or rump. The general colour of the upper-parts is at all seasons pure or tawny grey-fawn; the muzzle, a ring round each eye, the under surface of the lower jaw, the inside of the ear, the under-parts, and the inner surface and much of the lower portion of the legs, being pure white. Apparently there is no marked (if any) difference, either in colour or length, between the summer and the winter coat. The cry is a bray.

There are two wild races of the species, namely the Nubian Wild Ass (*Equus asinus africanus*, M. **1014**, fig. 26) inhabiting North-eastern Africa, that is to say Senaar and Nubia; its range formerly extending as far as the fifth cataract of the Nile, and eastwards to the River Atbara and the Danakil district, but not including Abyssinia. It is half-wild in Socotra. Year by year the range of this race appears to become more and more restricted; and unless measures be taken for its protection, there is danger that it may be exterminated. The race is characterised by its generally inferior size (ranging from about 3 ft. 9½ in. to 3 ft. 11½ in.) as compared with the Somali race, the generally greyish fawn-colour, the continuous, although very narrow dorsal stripe, the presence of a short shoulder-stripe, and of a dark patch on each side of the front fetlock, and the absence of distinct dark barrings on the legs.

It is represented in the lower mammal gallery by a male specimen (M. **1014**) from Nakheila, on the Atbara River, presented by the Hon. Charles N. Rothschild in 1904, and also by the head of a female from Yalalub, Eastern Sudan, given by Mr. H. W. Haig.

A small breed of Nubian Wild Asses inhabits the island of Socotra. These Asses, which appear to have been originally imported from the mainland, stand only about 3½ feet at the shoulder. They are characterised by perfect similarity in colour

and markings, the nose, a wide ring round the eye, as well as the chest and belly, being white, and the legs nearly so, thus contrasting strongly with the mouse-coloured head and back. The black stripes on the shoulder and down the middle of the back, and a few somewhat irregular dusky rings round the legs, are also clearly defined.

The second, or Somali, race (*Equus asinus somaliensis* M. **1015**), ranges from Somaliland, through Danakil and Gallaland, to the Red Sea. It is distinguished from the Nubian race by its superior size, the pale and more greyish colour, the absence of a shoulder-stripe, the slightly developed and discontinuous dorsal stripe, and the presence of a number of distinct black bars on the legs, and of a brownish patch on the front of each foot above the hoof. The head and ears are also relatively shorter, with less black on the front of the tips, the mane is longer and inclined to be pendent; and the white round the eye and on the muzzle is less pure and less sharply defined from the fawn, while there is no white on the under side of the lower jaw and the angle of the throat.

It is represented in the exhibited collection by a mounted male specimen (M. **10**) presented by Gen. Sir A. H. Fitzroy Paget in 1893.

The Domesticated Ass is undoubtedly the direct descendant of one or both of the wild races; and, unlike the Horse, exhibits very little variation from the ancestral type; such modifications as do exist being restricted to colour and size. The colour variations consist of a tendency to albinism on the one hand, and melanism on the other; the extremes being represented respectively by white and by black Asses. As regards size, the extreme modification is represented by the Dwarf Ass of India and Ceylon, which does not stand more than about two feet at the shoulder.

In Egypt the Ass was known in a domesticated state long previous to the Horse; and a skull from an Egyptian tomb (N. H. **24**), presented in 1900 by Professor Flinders-Petrie, is exhibited in the large Horse case in the north hall. The only other specimens illustrating this species are two skulls (N.H. **26**, **27**) male and female, from Aden, presented by the Royal Society in 1899.

Hybrids. It is propable that all the existing members of the Ho family will interbreed, although their offspring is alm invariably infertile. The most common hybrid is the Mule, t product of the male Ass with the female Horse; the opposite hyb being the Hinny, a much rarer cross. No specimen of either these hybrids is shown; the only hybrid Equine exhibited bein cross between a male Zebra (*Equus zebra*) and a female Ghor-kh or Onager (*E. onager*). In this hybrid (N. H. **125**), which w foaled in the Zoological Society's Menagerie in the Regent's Pa the general characters are those of the Ass, as is exemplified by t large ears, the strongly marked shoulder-stripe, and the near uniform body-colour. In the distinctly striped legs, as well as the darker flecking of the body (representing disappearing stripe Zebra-characters are, however, displayed; the striping of t Zebras and Quaggas, which appears to have been inherited fro the ancestors of the family, being a "prepotent" feature alwa strongly pronounced in hybrids of this nature.

Two other hybrids are represented by pictures. The first Prof. Ewarts' "Romulus," the offspring of a male Bonte-Quag or Burchell's Zebra (*Equus burchelli*) and a West Highland Po mare, of which two photographs are shown. The second, repr sented by a painting executed and presented by Miss Nellie Hadd in 1904, is a hybrid brought to this country by Lord Kitchen and presented to H.M. the King, by whom it was desposited the Menagerie of the Zoological Society. Its sire was a Pony, a its dam a Bonte-Quagga (Burchell's Zebra). It is notewort that although both these hybrids are very fully striped, t general body-colour (bay) of the Horse is retained.

A GUIDE

TO THE

ELEPHANTS
(RECENT AND FOSSIL)

EXHIBITED IN THE DEPARTMENT OF

GEOLOGY AND PALÆONTOLOGY

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ALERE FLAMMAM.

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PRÊFACE.

THE fossil remains of elephants in the Department of Geology are so numerous, and the ancestral history revealed by them is of so much general interest, that they appear worthy of a special Guide-Book. The present account of the collection has therefore been prepared by Dr. Charles W. Andrews, who has already published technical descriptions of some of the more important specimens in the Philosophical Transactions of the Royal Society (1903 and 1908), and in "A Descriptive Catalogue of the Tertiary Vertebrata of the Fayûm, Egypt" (issued by the Trustees of the British Museum in 1906).

The immediate ancestors of the modern elephants have long been known through the discoveries of Falconer and Cautley in the Pliocene formations of the Siwalik Hills in India; but the earliest members of the group have only been found during recent years in the Eocene deposits of Egypt. The whole of the Cautley Collection is exhibited in the Museum besides other fine specimens from the Siwalik Hills described by Falconer. The Egyptian discoveries also form an extensive collection, though many of the original specimens are in the Geological Museum, Cairo, and only represented here by plaster casts.

Among the illustrations, figs. 1 and 6 are reproduced from the "Encyclopædia Britannica" by permission of *The Times*.

A. SMITH WOODWARD.

DEPARTMENT OF GEOLOGY.
February, 1908.

GUIDE

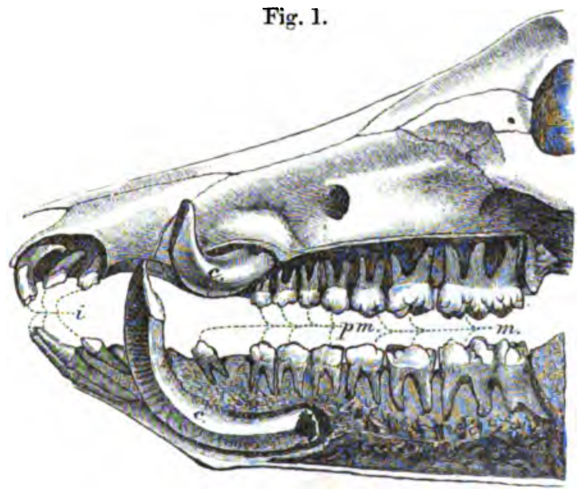
TO

ELEPHANTS (RECENT AND FOSSIL)

IN THE GALLERY OF FOSSIL MAMMALIA.

At the present day the different main sub-divisions of the Mammalia are, as a rule, very distinctly marked off from one

Fig. 1.

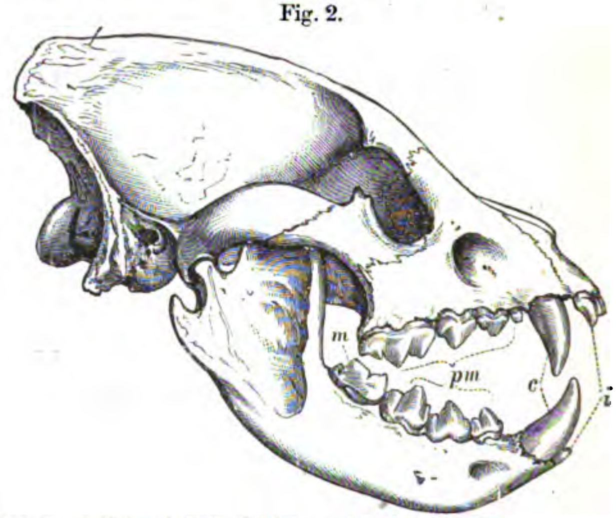


Upper and lower dentition of pig, showing the presence of the full set of 44 teeth and the low-crowned bunodont cheek-teeth adapted for a soft, mainly vegetable diet. *c.*, canine; *i.*, incisors; *m.*, molars; *pm.*, pre-molars.

another. For instance, the Carnivora (flesh-eaters, *e. g.*, tiger, bear) are now widely different from the Ungulata (hoofed-animals, *e. g.*, horse and ox), each of these groups being fitted for some special manner of life, and particularly for living on

some special kind of food. Thus, the principal character of most of the Carnivora is the possession of sharp claws and teeth for killing and devouring other animals; while, on the other hand, the vegetarian Ungulata have teeth fitted for grinding vegetable matter and feet adapted solely for moving from place to place in search of pasturage. If, however, we trace back through the earlier periods of the Earth's Geological

Fig. 2.



Skull and mandible of Striped Hyæna, showing the sharp cutting cheek-teeth adapted for a flesh diet. Lettering as in fig. 1.

History, the extinct animals from which these quite distinct modern groups are descended, we find that in nearly all cases in which these earlier fossil forms are well known, there is a tendency for them to become more and more alike. In the early Eocene, indeed (see table, p. 6), the Carnivora and Ungulata are not always to be distinguished from one another with certainty, so that the animals from which they and some other mammals have descended, may be placed in a single group. Nearly all these early mammals have certain characters in common: thus in most there are five toes on each foot and forty-four comparatively simply constructed teeth. Characters such as these are called "primitive," and when as time goes on they become gradually changed in different ways and adapted for particular purposes, they are said to be more

"specialised." Thus in the horse the foot (fig. 3) is extremely specialised, in that it has only a single complete toe instead of the primitive number, five: its limbs being specially fitted for swift movement over hard ground. To take another instance, the teeth of the tiger are said to be highly "specialised," because there are only thirty of the original forty-four, and these have become specially adapted for seizing living prey and

Fig. 3.

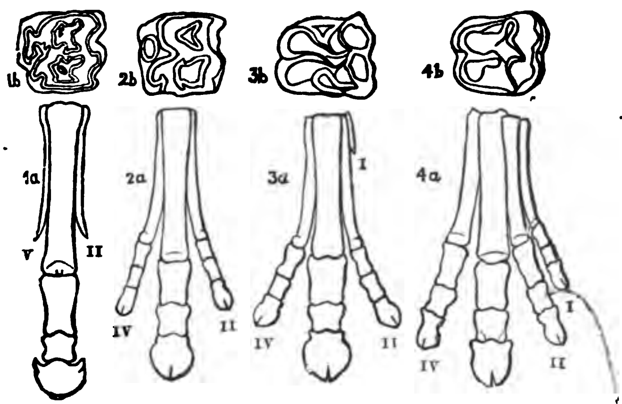


Diagram showing the gradual loss of toes on the fore foot (*a*) and increase of complexity in the grinding teeth (*b*) of successive horse-like Ungulata from Europe, namely *Hyracotherium* (Eocene), 4, *Anchitherium* (Miocene), 3, *Hipparion* (Pliocene), 2, *Equus* (Pleistocene and Recent), 1.

cutting and tearing its flesh. It must be added that *all* the characters of a group of animals do not necessarily become specialised, but that some may remain in the primitive condition. Thus man, in some ways the most highly specialised of mammals, still retains the primitive number of five digits on both limbs.

In order to trace back a modern specialised group of mammals to its early primitive ancestors, a long series of fossil remains from the successive geological periods is necessary. Unfortunately in many cases these fossils have yet to be found, but every year further discoveries are made and gaps of more or less importance are filled up. The series of changes undergone by a group of mammals is perhaps best known in the horse

family *, but recent discoveries of remains of early forms of the elephant-group in the Eocene beds of the Libyan Desert in Egypt, have made it possible to trace the history of the elephants also with considerable completeness, and in the present guide a short account of that history is given.

Among living mammals the elephants are perhaps the most remarkable. Not only do they exceed in size all other living land-animals, but they are further distinguished by the possession of a mobile trunk or proboscis, which is at once a sensitive organ of touch and a most efficient means of grasping objects, both large and small. Furthermore, the structure of their teeth reaches a degree of complication not to be found in any other animals. At the same time, though in many respects so peculiar, in others they retain primitive characters that have been lost in most of the other Ungulata, with which they are usually classed. The most notable of these primitive characters is the presence of the original five toes on each foot, while in most hoofed-animals the feet have become "specialised" by the loss of one or more of the digits.

It is now proposed to describe some of the principal stages by which the elephants gradually came to be what they are at the present day, and to show that the earliest known forms were much like other primitive hoofed-animals, a condition to which the pigs and tapirs among living mammals perhaps most nearly approach. It will be shown that the earliest known animal belonging to the Proboscidea or elephants was, in fact, not unlike a large pig (see fig. 8), though in some respects an even more primitive creature. From this beginning we can trace a gradual increase in size in the later forms, a gradual development of the trunk or proboscis, first as the upper part of a long snout supported by the elongated lower jaw, afterwards as the familiar movable organ so characteristic of the modern elephants. We can also observe the gradual increase in the size and degree of complication of the grinding-teeth, accompanied by the complete loss of many of the teeth

* Casts of specimens showing the gradual "specialisation" of the teeth and feet in the horses are shown in a case in the North Hall. See also pier-case 10 and table-case 5 in Gallery of Fossil Mammals.

Fig. 4.

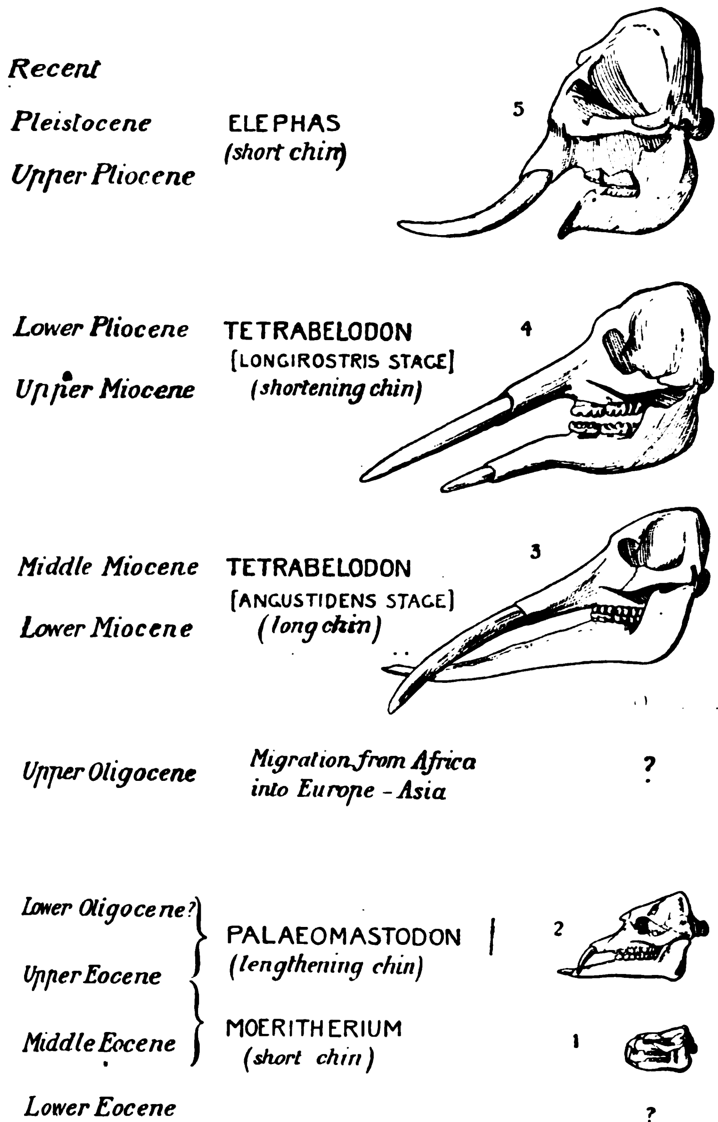


Diagram showing some stages in the gradual increase in size, and alteration in form of the skull and mandible, occurring in the Proboscidea from the Eocene to the present day.

found in the earlier forms. Finally, we have materials f
discussing the probable relationship of the elephants to so
other groups of animals.

Fortunately for the present purpose the British Muse
possesses the most extensive series of Proboscidean rema
to be found anywhere, so that except in very few instan
readers can see in the S.E. Gallery of Geology the act
specimens, or, at any rate, casts of the specimens, upon wh
the following descriptions are based, and can to some ext
check the accuracy of the various statements for themselves.

Before proceeding to the description of the animals, it m
be advisable to refer to the geolcgical horizons or periods
the Earth's history during which they existed and in the roc
of which their fossil remains are found; for it is necessary
know the order in which the different forms appeared on t
earth, just as in tracing the pedigree of a human fami
the dates of the documents upon which it is founded m
be known. It will be seen from the following table that t
history of the life of the Earth falls into several great peri

TABLE 1.

CÆNOZOIC	QUATERNARY	RECENT.
		PLEISTOCENE.
	TERTIARY	PLIOCENE.
		MIOCENE.
		OLIGOCENE.
		EOCENE.
MESOZOIC or SECONDARY		CRETACEOUS.
		JURASSIC.
		TRIASSIC.
PALÆOZOIC or PRIMARY		PERMIAN.
		CARBONIFEROUS.
		DEVONIAN.
		SILURIAN.
		ORDOVICIAN.
		CAMBRIAN.

to which names have been given by geologists. The earliest o
these is called the Primary or Palæozoic Period, and durin

it the only backboned animals were fishes, amphibians (represented at the present time by newts, frogs, &c.), and, towards the end, some reptiles. In the next great period, the Secondary or Mesozoic, the reptiles were of the greatest importance: they were very numerous and some were of gigantic size. They became fitted for various modes of life, some inhabiting the land, others the sea; some living on a vegetable diet, others on flesh. During this period also the birds began to come into existence, and remains of the most remarkable of the early forms of birds, *Archæopteryx*, are shown in table-case 13. At the same time the first of the warm-blooded mammals arose, though they were as yet insignificant in size and numbers. The third period, the Cænozoic, is that with which we are chiefly concerned. During it the reptiles became of little importance, while, on the other hand, the mammals took their place, becoming extremely numerous, many of them of great size, and adapted to every kind of life and food. The latter part of this period, sometimes called the Quaternary, extends till the present day, and during it the mammals still continue to be the prominent backboned animals, but one of them, man, has become by far the most important inhabitant of the world, and instead of merely being slowly fitted to new conditions of life, now to a large extent controls the conditions and changes them to suit his own convenience.

The second table (p. 8) shows what are the chief forms of Proboscideans living at the different periods and their distribution over the world. It will be seen that the earliest mammal which can be definitely called a Proboscidean is *Moeritherium*, a small tapir-like creature from the Middle Eocene beds of the Fayûm district of Egypt. This species existed also in the Upper Eocene of the same region, but was then accompanied by a larger and much more elephant-like animal, *Palæomastodon*. At this time Africa was cut off from the rest of the world to the north by a broad and deep sea which extended from the Atlantic to the Pacific by way of Northern India and Southern China, and the separation of Africa prevented these early forms of elephant from wandering into other regions till after the Eocene. After *Palæomas-*

TABLE 2.

	Europe.	Asia.	Africa.	N. America.	S. America.
Recent	....	*Elephas* (*E. maximus*).	*Elephas* (*E. africanus*).	....	....
Pleistocene	*Elephas.*	*Elephas.*	*Elephas.*	*Elephas* and *Mastodon.*	*Mastodon.*
Pliocene............	*Elephas.* *Mastodon.*	*Elephas.* *Stegodon.* *Mastodon.*	....	*Mastodon.* *Tetrabelodon.*	....
Miocene............	*Tetrabelodon.* *Dinotherium.*	*Stegodon.* *Mastodon.* *Tetrabelodon.* *Dinotherium.*	*Tetrabelodon.*	*Tetrabelodon.*	....
Oligocene	....	....	....	....	
Eocene .. Upper ..	....	....	*Palæomastodon* *Moeritherium.*	....	....
Eocene .. Middle..	....	....	*Moeritherium.*	....	....

TABLE SHOWING THE GEOGRAPHICAL DISTRIBUTION OF THE PROBOSCIDEA AT DIFFERENT GEOLOGICAL PERIODS.

todon there is a large gap in the series, no fossil Proboscidea having yet been found in the Oligocene, though no doubt their remains will be discovered somewhere in the freshwater deposits of that age in Egypt. Hitherto no Proboscidean bones and teeth have been met with again till the Lower Miocene, but in rocks of that period they are found abundantly, not only in Egypt, but in Europe, Asia, and North America. It is therefore clear that during the long lapse of time after the Eocene, the deep sea above referred to, must to some extent have been replaced by land, over which the early elephants could spread outwards from their home in Africa. The vast changes in the distribution of land and water that took place in this region, will be apparent when it is understood that rocks crowded with the shells that lived at the bottom of this ancient sea are to-day found thousands of feet above the sea-level in India and elsewhere.

From the Lower Miocene period onwards we meet with elephant-like animals in great variety all over the Northern Hemisphere, wherever suitable deposits for the preservation of their remains occur. At the end of the Pliocene period the group also spread into South America, but at the present day it is totally wanting in the whole Western Hemisphere.

During the later Miocene and Pliocene periods the headquarters of these animals seem to have been in India, for it is there that we meet with the greatest number and variety of forms, showing all grades of structure between the Miocene types above referred to and elephants almost like those now existing. From the end of the Pliocene to the beginning of the Quaternary Period may be regarded as the time during which the elephants reached their most flourishing condition, both in the number of kinds that existed and in the wide range over which they were spread. After this a gradual decline in the group took place, till, at the present day, it is represented by two species only, the African elephant confined to Tropical Africa, and the Indian elephant found in India, Ceylon, Burma, the Malay Peninsula, and some of the neighbouring islands. But for restrictions placed upon their slaughter even these last remnants of one of the oldest, and in many

ways the most remarkable, groups of mammals would soon disappear, just as has happened for instance, in the case of the great ground-sloths of South America, the giant lemurs of Madagascar, and the giant marsupials such as *Diprotodon* in Australia.

A more detailed account of the changes that the Proboscidea have passed through will now be given, the following animals being selected for description as representing six of the most important of the successive stages at present known.

1. *Moeritherium lyonsi*, Middle and Upper Eocene.
2. *Palæomastodon beadnelli*, Upper Eocene.
3. *Tetrabelodon angustidens*, Miocene.
4. ,, *longirostris*, Lower Pliocene.
5. *Stegodon insignis*, Pliocene.
6. *Elephas*, Pliocene, Pleistocene, and Recent.

Some reference will also be made to other types, such as *Dinotherium* and *Mastodon*.

Wall-case 43. Table-case 24.

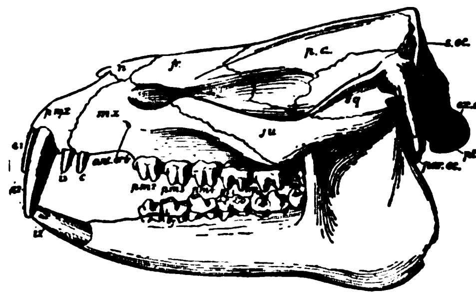
Moeritherium (figs. 5, 7, 8) was an animal about the size of a large Newfoundland dog, or of the tapir, which it must have much resembled in general appearance. It was common in the region that is now known as the Fayûm in Lower Egypt, where its fossil remains occur in considerable quantities in the Middle Eocene beds, intermingled with bones of toothed whales (*Zeuglodon*), sea-cows (*Eosiren*), marine turtles (*Psephophorus* and *Thalassochelys*), and snakes (*Pterosphenus*), as well as skeletons of fishes. From this mixture of land and aquatic animals it may be concluded that *Moeritherium* lived near the shore, probably in swamps at the mouth of a great river, where the remains of both marine and of drowned land-animals would be mingled and entombed together in the muds and clays, which accumulated in the estuary and now make up much of the strata found in this locality. In the Upper Eocene beds, overlying those just described, remains of *Moeritherium* are also found; here, however, there is no intermingling of marine animals, but instead we find remains of many remarkable land-mammals, crocodiles, and immense

quantities of trunks of fossil trees, embedded in the sands and gravels of a great river. Probably both the animals and the tree-trunks were swept away by floods, their remains piled up in shallows and places where the current was slack, and buried in the mud and sand carried down by the stream.

Wall-case 43. Table-case 24.

The skull of the *Moeritherium* (see fig. 5) differs in no

Fig. 5.



Skull and lower jaw of *Moeritherium* from the Middle Eocene of the Fayûm, Egypt. $\frac{1}{7}$ nat. size.

ant.orb., antorbital foramen; *c.*, canine; *ex.oc.*, exoccipital; *fr.*, frontal; *i.* 1-3 incisors; *ju.*, jugal; *m.* 1-3, molars; *mx.*, maxilla; *n.*, nasal; *p.a.*, parietal; *par.*, paroccipital; *pm.* 2-4, premolars; *p.mx.*, premaxilla; *pt.*, post-tympanic process of squamosal; *s.oc.*, supra-occipital; *sq.* squamosal.

very marked manner from that of other primitive hoofed-animals, and shows scarcely any trace of the peculiarities of the skulls of the later Proboscidea. The most important feature is the large nasal opening not quite at the end of the snout, the nasal bones being short; this indicates that probably there was already a short proboscis, something like that of the tapir. Another interesting point is that some of the bones at the back of the skull are thickened and contain air-chambers; in the later elephants this development of air-cells is carried to such an extent that the whole form of the skull, particularly the posterior portion, is entirely altered by it (see the broken skull of the Indian elephant, stand G in Gallery). The reason for this swelling of the bones is, that as the head becomes heavier, owing in great part to the development of the trunk

and tusks, a larger surface for the attachment of the muscles which support the head is necessary, and even in the small Eocene *Moeritherium* change in this direction had begun.

In the fossil mammals it is the teeth that are of the greatest importance in settling the relationships of different species to one another, and in forming an opinion as to their food and probable manner of life.

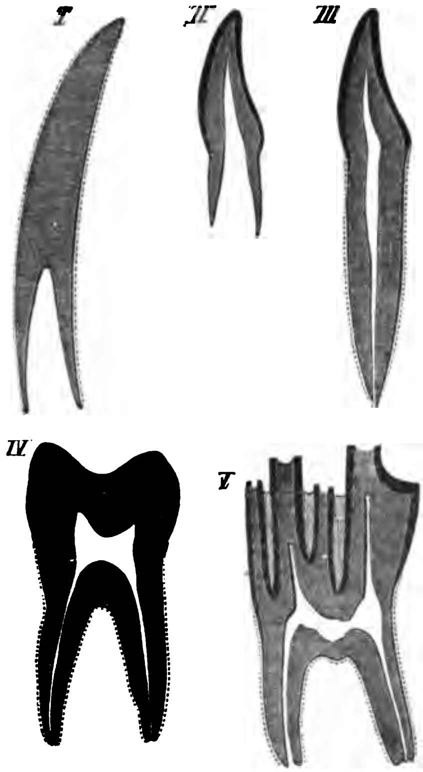
The reason for the importance of fossil teeth is, that while in many ways they are very conservative, long retaining traces of the earlier forms from which they have originated, nevertheless they readily undergo change in accordance with the kind of food they are called upon to seize and masticate. Moreover, from their hardness they are more frequently preserved than most other parts of the skeleton. It will be well, therefore, before considering the teeth of *Moeritherium* and the other Proboscidea to give a short account of mammalian teeth in general, so that the descriptions later may be understood.

Central Hall, Bay I.

The tooth of a mammal (see Mammalia in Index collection in Central Hall) consists of a root or roots embedded in a socket in the jaw, and a crown which is exposed and is adapted for the work it has to perform. In a section of a tooth (fig. 6) it is seen that the greater part is composed of a hard material called dentine, and that the crown of the tooth is usually covered with a still harder substance known as enamel, while in some cases the root, and in others (usually the more complicated forms) both root and crown, may be coated with a softer bony matter, called cement. The form of the crown differs enormously in different animals and in different parts of the mouth: it may be a simple cone like the canine or dog-tooth, or it may form a large complicated grinding surface as in the back teeth of the horse. The teeth are usually divided into different series according to their particular position in the mouth and the duties they have to perform (see figs. 1 & 2). The front teeth implanted in the anterior part of the jaw are mainly concerned in grasping and biting off the food: these are called incisors. In mammals which, like the pig (fig. 1), possess the primitive number of teeth, there are three of these on either side in both upper and lower jaws. Behind these come the

canines, one on each side above and below; these are generally more or less pointed teeth, serving chiefly for fighting or defence.

Fig. 6.



Diagrammatic section of various teeth.

1. Section of tusk of elephant, a permanently growing tooth. II. Section of a young human incisor still growing, the root not yet fully formed. III. Section of human incisor fully formed, the root being complete. IV. Section of human molar showing the low-crowned (brachyodont) condition, the cusps being rounded tubercles (bunodont). V. Section of the molar of an ox, showing the high (hypsodont) complexly folded crown. In the figures the enamel is black, the pulp white, the dentine represented by horizontal lines, the cement by dots.

Behind these again are the cheek-teeth which have to do mainly with the breaking up of the food before it is swallowed: in the

Central Hall, Bay I.

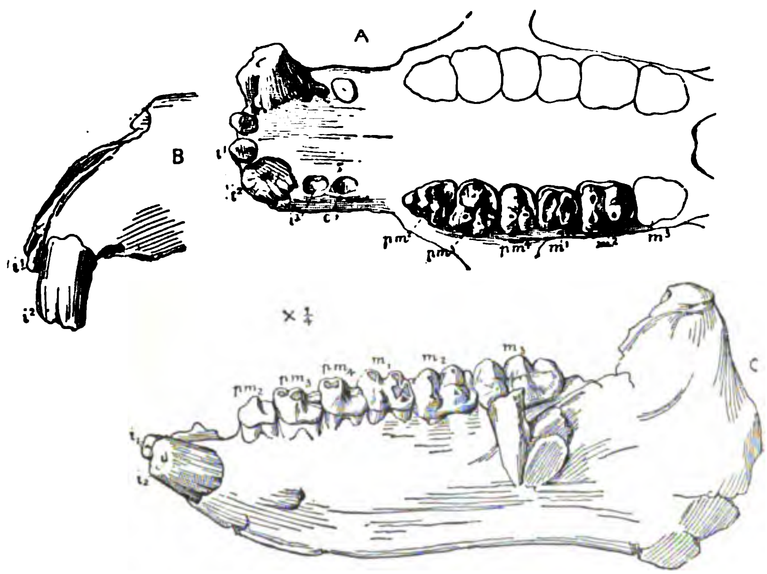
complete dentition there are seven of these on either side in b jaws and they are divided into two groups, (1) four premo in front, and (2) three molars behind: the premolars, o least those posteriorly, replace the milk-molars of the yo animal, while the molars have no predecessors. It is in premolars and molars that the greatest variety of structur found, as might of course be expected, because it is these te that are most affected by the nature of the food. Teeth suita for cutting up flesh would be quite unfitted for grinding h vegetable matter, and consequently in animals feeding on s material the teeth differ widely from those in which the foo hard and requires much mastication. In the former the cro of the teeth are low and their cusps or tubercles are eit sharp and cutting in the case of flesh-feeders (*e. g.*, lions a tigers) or rounded (bunodont) in the case of animals feeding a soft vegetable or mixed diet (*e. g.*, pigs and bears). Te of this sort are called brachyodont (fig. 6, IV). In the case animals whose food is hard and requires much grinding, t wear of the teeth is so great that simply-constructed low crow would be quickly worn out, and it must be remembered th the length of an animal's life is largely dependent on the ti during which its teeth remain in good working order. To m the increased wear the crown of the tooth becomes higher a moves up in the gum as wear takes place, sometimes throug out the animal's life or only for a time; teeth of this s are called hypsodont (fig. 6, V). With this increase in heig of the crown there is generally greater complication resulti from the infolding of the enamel in various ways, and t development of cement on the crown as well as on the roo One example of this gradual increase of height and complicati is about to be described in the case of the elephants; anoth extremely good instance is found in the gradual evolution the teeth in the horses, as excellently illustrated in the case the North Hall and in table-case 8 (see fig. 3).

From the above account it will be seen that when the fu number of teeth is present there are three incisors, one canin four premolars, and three molars on each side in the upper ja and the same in the lower jaw. This is usually expressed short

by a formula, thus :—I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{4}$, M $\frac{3}{3} = \frac{11}{11}$, the letters denoting the kind of teeth, the upper numbers the number of each kind on one side in the upper jaw, the lower numbers those in the lower jaw, so that in the example above given there would be eleven teeth on each side in both the upper and lower jaws, or forty-four in all. As has already been mentioned, a greater or less number of these teeth may be wanting in different animals and the formula will differ accordingly: thus in man it is I. $\frac{2}{2}$, C. $\frac{1}{1}$, Pm. $\frac{2}{2}$, M. $\frac{3}{3} = \frac{8}{8}$ or thirty-two in all. In the cat it is I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{3}{2}$, M. $\frac{1}{1} = \frac{8}{7}$ or thirty in all.

With these preliminary remarks we may proceed to describe Wall-case 43. Table-case 24.

Fig. 7.



Upper and lower teeth of *Moeritherium*.

A. Upper teeth. B. Premaxilla, large tusk-like second incisor. C. Mandible from outer side. *c.*, socket of canine ; *i.* 1-3, incisors ; *m.* 1-3, molars ; *pm.* 2-4, premolars. $\frac{1}{4}$ nat. size.

the teeth of *Moeritherium* (figs. 5 & 7). In this animal the dental formula is I. $\frac{3}{2}$, C. $\frac{1}{0}$, Pm. $\frac{3}{3}$, M. $\frac{3}{3} = \frac{10}{8}$ or thirty-six in all.

Wall-case 43. Table-case 24.

From the formula it will be seen that in the upper jaw only one premolar is wanting to complete the primitive number, while in the lower jaw an incisor and the canine are missing on each side in addition to the premolar.

Of the upper incisors the second pair (*i.* 2) are greatly enlarged and form strong downwardly directed tusks, the beginning of the great tusks so characteristic of the later elephants. The canine (*c.*) seems to have been quite small and unimportant, being on the way to disappearance. The premolars (*pm.*) are separated from the canine by a short interval, and as already mentioned the anterior one of the full dentition is wanting. The remaining premolars are all simpler in structure than the molars behind them, and consist of three main cusps only, the two front cusps being arranged in a transverse line in the third and fourth premolars. These teeth are preceded by milk-teeth which they displace from above as in the ordinary mammals; in the later elephants we shall see that this usual replacement of milk-teeth by premolars is gradually lost.

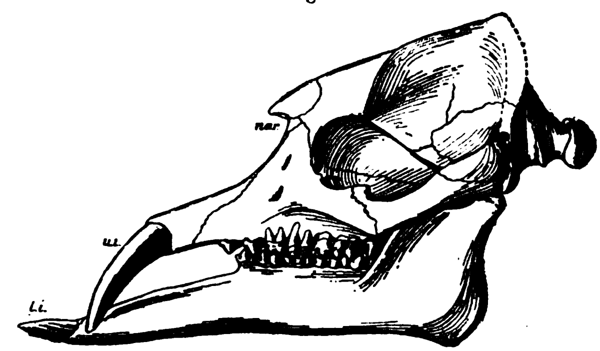
The molars (fig. 7 A, *m.*) are the most interesting and important of the teeth, because it is in them that the most nearly complete series of gradually more and more complicated forms can be traced. In *Moeritherium* the crown of each upper molar is composed of two transversely arranged pairs of knobs, giving rise to a pair of transverse crests; there are also in many cases small posterior knobs—the first trace of the tendency to increase the number of transverse crests by additions to the back of the tooth, which is characteristic of the whole group.

In the lower jaw (figs. 5 & 7 C) the middle incisors (*i* 1) are small, the second pair (*i* 2) large and tusk-like; both are directed forward and their upper surface continues forward the surface of the spout-like anterior portion of the jaw. The third incisors, the canine, and the first premolar of the full dentition are wanting. The remaining three premolars (*pm.*), which replace milk-molars, are simpler than the molars, and only in the third and fourth is there any arrangement of the anterior cusps to form a transverse ridge. The first and second molars (fig. 7 C), like those of the upper jaw, consist of two transversely-arranged pairs of knobs and a posterior knob which is larger

structure of the skull and teeth, as well as in the rest of the skeleton, so far as known, the advance is likewise very striking. Wall-case 43. Table-case 24.

In the skull (see fig. 9) the opening of the nostril (*nar.*) has shifted far back from near the end of the snout, though it is still in front of the orbit of the eye. The nasal bones are still

Fig. 9.



Skull and lower jaw of *Palæomastodon*, showing the elongated chin with a pair of terminal incisors (*l.i.*), from the Upper Eocene (? Lower Oligocene) of the Fayûm, Egypt. $\frac{1}{12}$ nat. size.

nar., position of opening of nose; *u.i.*, upper second incisor or tusk.

shorter and smaller than in *Moeritherium*. At the back of the skull the development of air-cells in some of the bones has enormously increased, but has not yet invaded the roof of the skull, so that the sides are only separated by a sharp median crest. The posterior surface of the skull slopes forward, and there is a deep pit in the middle line for the attachment of the muscles necessary to support the increasingly heavy head.

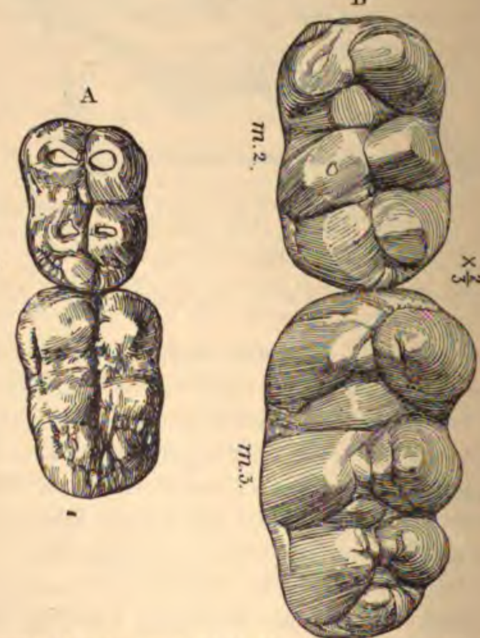
Of the incisor teeth only the second pair now remains, and these have been still further enlarged, forming downwardly directed curved tusks with a band of enamel along their outer sides only. The canine has disappeared, but there are still three premolars replacing milk-molars. The anterior premolar is a simple cone, while the crown of the posterior one consists of two transverse ridges, these teeth being subjected to two distinct influences, namely, the tendency to the reduction in the front of the series, and the tendency to become more like the

Wall-case 43. Table-case 24.

molars at the back. The molars themselves show a distin[illegible] advance, the crown of each consisting of *three* transverse ridg[illegible] each ridge composed primarily of two main cusps which ma[illegible] however, show small traces of sub-division into secondary cus[illegible]

The mandible (figs. 9 & 13) differs from that of *Moeritherium* [illegible] the much greater prolongation of the spout-like anterior portio[illegible] this now projects a considerable distance in front of the sk[illegible] and is prolonged still further forward by the single remaini[illegible] (second) pair of incisor teeth, which meet in the middle line a[illegible] form a sort of shovel-shaped extension ; the edges are worn b[illegible]

Fig. 10.



Posterior lower molars (m_2, m_3) of (A) *Moeritherium* and (B) *Palæomasto[illegible]* showing the increase in the number of ridges of *Palæomastodon*. [illegible] size.

on the upper and lower surface, so that these teeth were p[illegible] bably used for grubbing about in the ground to procure fo[illegible] and the upper surface must have been further worn by wo[illegible] against the lower surface of the trunk or elongated upper lip

There are only two premolars in the lower jaw, the anterior of the three milk-molars (figs. 9 & 13) falling out without being replaced from below; the molars are three in number, the two anterior with three transverse ridges, the third sometimes having in addition a small heel (fig. 10). It should be noticed that in the full-grown animal all the molars and premolars are in position and use at the same time; it will be seen that in the later forms of elephant-ancestors this is not so. Wall-case 43. Table-case 24.

The skeleton, so far as known, is almost exactly like that of a small elephant, the only important differences being that the neck is longer and the limbs most likely less massive. The animal as a whole (fig. 11) must have been very like a small elephant, but would be distinguishable by the longer head and neck, and by the fact that instead of possessing a flexible trunk it had a long snout, the lower portion consisting of the elongated lower jaw, the upper without bony support and probably extending beyond the lower; the projecting portion most likely was more or less flexible and capable of seizing objects, and was the beginning of the prehensile trunk.

The chief steps taken by *Palæomastodon* in advance of *Moeritherium* towards greater likeness to the later elephants are:—

1. Considerable increase in size.
2. Lengthening of the snout, as shown by the mandible.
3. Loss of canines and all the incisors except the second pair in both jaws.
4. Three-ridged molars.
5. Greater development of air-cells at back of skull.
6. Shifting further back of the nose-opening and smaller size of the nasal bones.
7. Greater similarity of the bones of the skeleton to those of ordinary elephants.

The next stage is found in *Tetrabelodon angustidens* (figs. 12–14), from the Lower Miocene of Northern Africa, Europe, and probably Asia. This animal is as large as a medium-sized elephant, and its teeth and skull are much more elephant-like than in *Palæomastodon*. Thus the nostrils have shifted still further back, and the great development of air-cells in the bones Pier-cases 41, 42. Table-case 23.

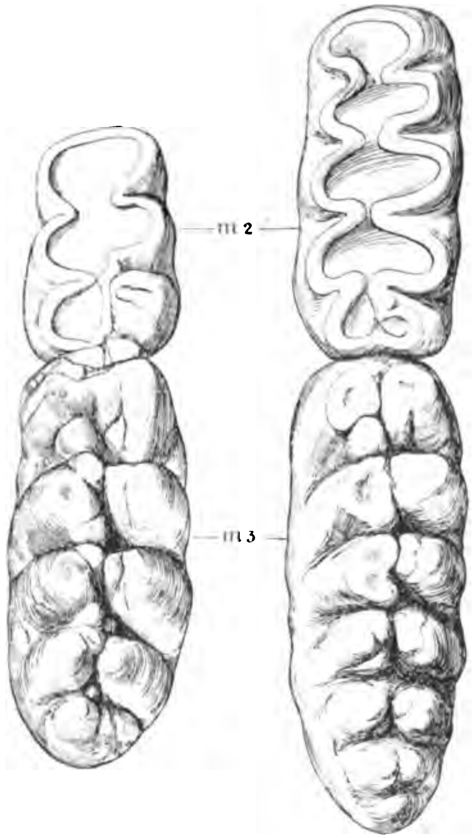
Fig. 11.

Restoration of Palæomastodon. Animal from 4 ft. to 6 ft. high, according to species.

snout which was supported by the elongated front of the lower jaw. Probably the end of the upper lip and nose was free and moveable, and may even have been able to grasp objects to some

Pier-cases 41, 42. Table-case 23.

Fig. 16.



Second and third lower molars of (A) *Tetrabelodon angustidens*, and (B) *Tetrabelodon longirostris*. $\frac{1}{3}$ nat. size.

extent, but the whole arrangement seems to be rather clumsy. In most groups of animals as size increases the length of the neck becomes greater in proportion, so that the animal can still reach the ground; but in these early elephants, in spite of

Pier-cases 41, 42. Table-case 23.

the great increase in size, the neck actually shortened, and it was only this extraordinary lengthening of the snout that enabled the animals to reach to feed or drink.

The next stage in this strange history is found in *Tetrabelodon longirostris* (fig. 15), an elephant of which the remains are common in the Lower Pliocene of Eppelsheim in Germany and other localities. In this animal the skull, so far as known, does not differ to any great extent from that of *Tetrabelodon angustidens*. The teeth, however, have advanced considerably in size and complication. The first and second molars may have four or five transverse ridges, while in the last there may be as many as six ridges (fig. 16 B). Only one of the milk-molars is now replaced by a premolar, and both this and the other milk-molars are early pushed out by the forward growth of the large molars, only two of which at most on each side remain in position in old animals. It is in the lower jaw, however, that the chief changes have taken place. Here the elongated anterior part (fig. 15), so striking in the last type, has become shortened till it projects but little in advance of the skull, and although its upper surface is still deeply grooved and spout-like as in the earlier forms, the lower incisors no longer meet in the middle line and prolong the spout, but are rounded and separated from one another. In this animal it is clear that the lower jaw was shortening up and could no longer reach the ground, but doubtless the fleshy upper lip and nose, now freed from their bony support for at least part of their length, became flexible and better adapted for grasping the animal's food. In fact, this species must have looked much the same as a modern elephant, except that it had a longer chin bearing a pair of small downwardly directed tusks.

In some of the American Tetrabelodons of about the same age as *T. longirostris*, the lower tusks, instead of undergoing reduction, seem to have become greatly enlarged, and at the same time the symphysial portion of the mandible is slightly deflected, so that the mandible with its tusks is to some degree similar to that of *Dinotherium*. An example of this form of jaw is seen in the case of the mandible of a Tetrabelodon, from the Loup Fork Beds (Upper Miocene) of Kansas, exhibited in pier-case 42.

This species has, of course, no near relationship with *Dinotherium* (fig. 17), which forms a side branch of the Proboscidea, and is widely different from all the other members of the group. The earliest known member of the genus is *Dinotherium cuvieri*, a comparatively small animal, which is

Wall-case 43. Case C.

Fig. 17.

Skull of *Dinotherium giganteum* from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt. $\frac{1}{15}$ nat. size.

found in the same deposits as the earliest known remains of *Tetrabelodon angustidens*, and, as in the case of that species its ancestors probably lived in Africa, though up to the present no traces of them have been discovered. In the later Miocene beds occur a number of species, some of enormous size (e. g. *D. gigantissimum* from Roumania). The genus finally disappears in Lower Pliocene times. The chief peculiarity of these animals is, that the front part of their lower jaw is turned sharply downward and bears two large tusks (fig. 17,

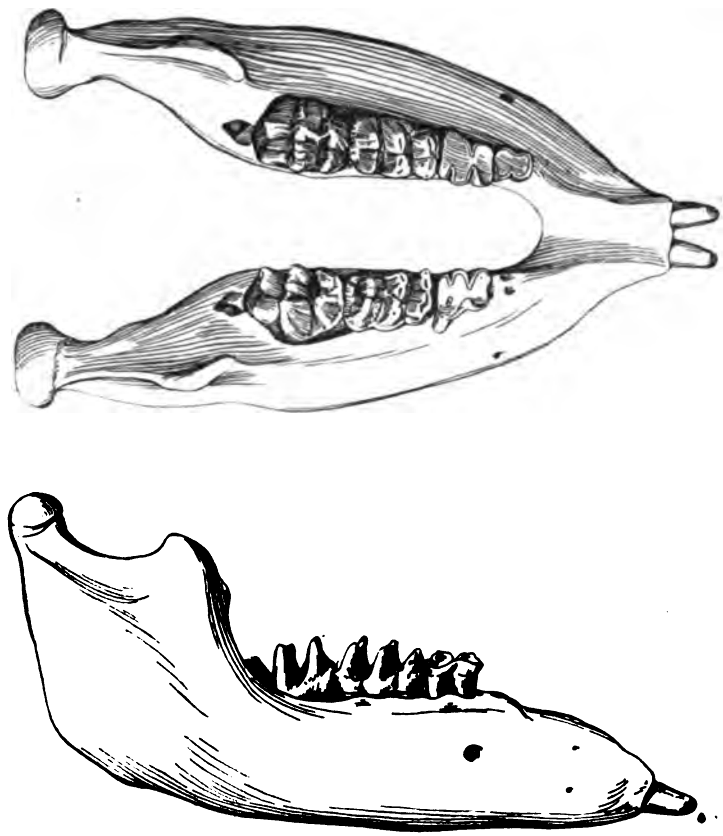
Wall-case 43. Case C. case C.); it is not certain whether or not there were any tusks in the upper jaw. The teeth are of a much simpler character than those found in the Mastodon-elephant line. In the upper jaw of the adult there are two premolars, both simpler than the molars; of these latter the anterior one consists of three transverse crests, the other two of two crests only, a notable peculiarity, since in the other Proboscidea it is the hindermost molar which is the most complex. The posterior milk-molar also has three crests. In the lower jaw in addition to the down-turned tusks there are two premolars and three molars. As in the upper jaw, the premolars are simpler than the molars: the anterior molar has three crests, the second and third two only, though in the last there may be a trace of a third. In the young there are three milk-teeth, the hinder one having three crests, like the anterior true molar. All the molars and premolars remain in use throughout the animal's life, a condition already lost in the earliest Tetrabelodons, as has been already described. It has been suggested that *Dinotherium* was a more aquatic animal, but there is nothing in the structure of the limbs to give any support to this idea, though the lowness of the crowns of the teeth probably indicates that it lived on soft herbaceous vegetation, such as may have grown in swampy places.

Pier-cases 41, 42. In *Tetrabelodon longirostris* the main characteristics of the modern elephants are already established, and the later changes of importance include, (1) the still further reduction of the mandibular symphysis and the loss of the lower incisors, and (2) the great increase in the size and complication of the cheek-teeth. It will be convenient to consider these changes separately.

Pier-case 37. In the shortening of the chin the next stage is found in Pliocene forms like *Mastodon atticus* from the Lower Pliocene of Pikermi. In this the symphysis, though much shortened, is still more or less spout-like, and in very young individuals the incisors may be present, though they are soon shed; the absence of these teeth in the adult is the chief character distinguishing the genus *Mastodon* (fig. 18) from *Tetrabelodon*. One of the best known species belonging to this stage of

development is *Mastodon arvernensis,* which is found in Europe in Pliocene deposits; in it the lower incisors seem to be entirely wanting, and the anterior molars have four transverse ridges. Pier-cases 37-40.

Fig. 18.



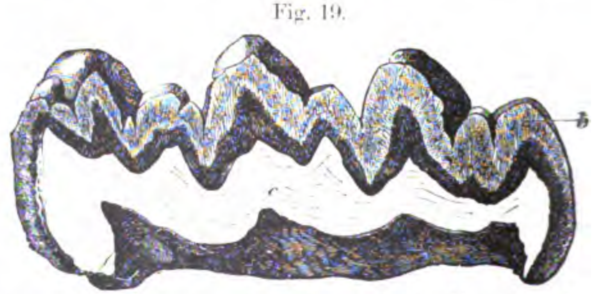
Mandible of a young individual of *Mastodon americanus* showing the small remnants of the lower incisors. In the adult these are lost. From a Pleistocene Deposit, North America. About $\frac{1}{7}$ nat. size.

A nearly allied species, *M. sivalensis* (fig. 20), from the Pliocene of India, is notable as showing a tendency to acquire five ridges to its molars.

The region in which the passage from the Mastodons to the true elephants occurred, seems to have been Southern Asia,

Pier-cases 39–42. where, in a succession of Pliocene and Pleistocene deposits, there is a complete series of forms passing from the Mastodon up to the recent Indian Elephant. How far these changes may have gone on in the rest of the Northern Hemisphere is not known, but the history of the Mastodons in America is rather different from that of the Old World forms. The first members of the group to appear in North America are found in the Loup Fork (Upper Miocene) beds of Montana, Nebraska, and Kansas, and include Tetrabelodonts and Mastodons, with such species as *T. campestris*, *T. euhyphodon*, *T. productus*, &c. Some of these species have simpler teeth than *T. longirostris*, and in this respect approach *T. angustidens*. The presence of these animals must be attributed to immigrations probably from Asia, since no Proboscidean remains occur in the earlier Tertiary beds of North America. The great increase in the size of the lower teeth of *T.* (?) *precursor*, just described, seems to show that some of these American species at least had turned away from the main line of advance and become changed in particular directions, so that it is uncertain whether the later types, in which the lower tusks were

Fig. 19.



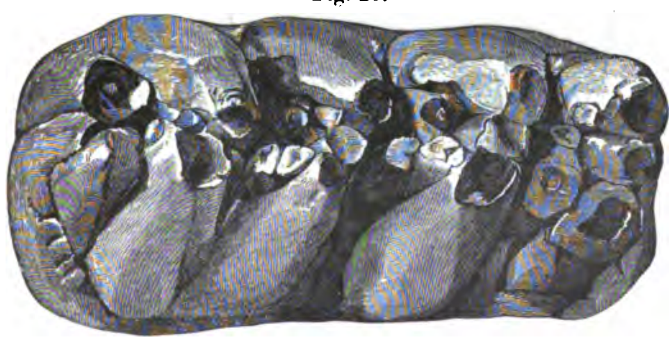
Vertical longitudinal section of a molar tooth of a Mastodon, showing the low crown, the open valleys between the cross-ridges and the thick enamel (*b*). *c*., dentine. $\frac{2}{3}$ nat. size.

reduced and finally lost, are descendants of these or represent further invasions from outside. These later forms spread into South America, where several peculiar species are found which Stand B. persisted with little change till the Pleistocene. Probably the reason why these Mastodons, as well as *M. americanus* of North

America, continued in a comparatively primitive condition, is to be found in their considerable isolation and freedom from competition. One South American species, ***M. andium***, is particularly interesting on account of its variability, especially in the length of the chin and in the presence or absence of the lower tusks. Some of these differences are due to sex, and perhaps age, but the variations are no doubt mainly due to the fact that the symphysis and lower tusks were undergoing reduction and that the latter were about to disappear altogether. Neither in North nor in South America does it appear that the Mastodons gave rise to more advanced types, and the presence in the Pleistocene of North America of true elephants (***E. columbi*** and ***E. primigenius***) is due to immigration from Asia. No species of ***Elephas*** reached South America. Pier-cases 39, 40.

To return to the series of stages of development found in Southern Asia, the first species that need be considered is ***Mastodon cautleyi***, which in the character of its teeth is nearly related to ***Tetrabelodon longirostris***, but the ridges of the molars are comparatively higher. There is, however, as yet no cement in the valleys (fig. 19), which are more or less obstructed by small tubercles, and the inner cusps wear into a trefoil pattern, Pier-case 37. Table-cases 23, 24.

Fig. 20.



Grinding surface of a lower molar tooth of *Mastodon sivalensis*. From the Lower Pliocene of the Siwalik Hills, India. $\frac{2}{3}$ nat. size.

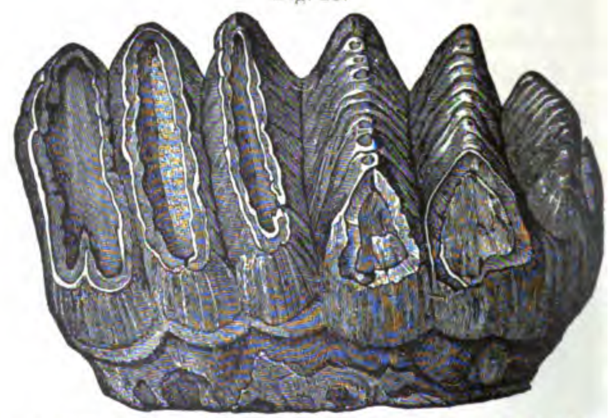
as in ***Tetrabelodon angustidens*** and *T. longirostris*. While, however, the anterior molars are almost identical with those of ***T. longirostris***, the posterior lower molar is very similar to that

of *M. latidens*, which in its turn approaches *Elephas* (*Stegodon*) *clifti* (fig. 21) very closely. In *M. latidens* there are as a rule five transverse ridges in the second upper molar and six in the last.

Pier-cases 35, 36. Table-case 24. Stand J.

The next stage is represented by *Elephas* (*Stegodon*) *clifti* (fig. 21). With this species we reach the true elephants, though the molars have much lower crowns and fewer transverse ridges than in the modern species of *Elephas*; and, in fact, these earlier forms are sometimes separated into another genus called *Stegodon*. Since, however, no real line can be drawn between them and the later types it is perhaps best to call all *Elephas*, but distinguish these earlier forms by adding the name *Stegodon* in brackets as above. In all this group the lower incisors have entirely disappeared, the anterior elongation of the chin at

Fig. 21.



Grinding surface of an upper molar tooth of *Elephas* (*Stegodon*) *clifti*. From Lower Pliocene, Siwalik Hills, India. Showing six transverse ridges. ½ nat. size.

the same time being reduced to a mere peg-like process (figs. 23 & 30), and a greater or less amount of cement (see above, p. 12) fills the transverse valleys in the crowns of the molars (fig. 22). In *Elephas* (*Stegodon*) *clifti* the number of ridges is greater than in *Mastodon cautleyi*. In order to express briefly the number of ridges in the molars of this and other species, a formula is used thus:—In *E. clifti* the formula

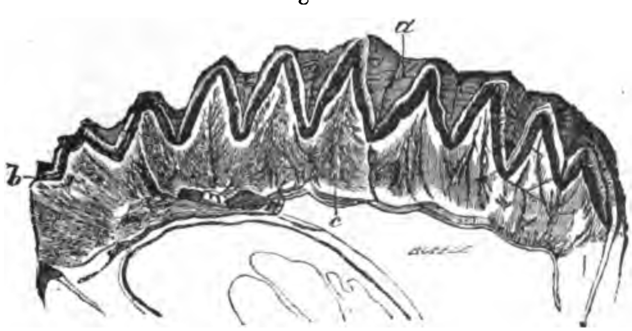
M 1 $\frac{6-7}{?}$, M 2 $\frac{6}{?}$, M 3 $\frac{7-8}{7-8}$, means that in the first true molar (M 1) there are in the upper jaw 6–7 ridges, while in this case the number in the lower is not known. In the second molar (M 2) there are 6 in the upper, the lower being uncertain, while in the last molar (M 3) there are 7–8 ridges in both the upper and lower jaw. It will be seen, therefore, that the numerator of the fractions represents the number of ridges in the upper teeth, the denominator the number in the lower. When the two numbers are given thus, 6–8, it means that the number of ridges varies between them. This formula will be employed below in describing the molars, and a table showing the gradual increase in the number of ridges will be given at the end.

Pier-cases 35, 36. Table-case 24. Stand J.

In *E. clifti* premolars are still developed, but must have been pushed out almost as soon as the milk-molars they replace. The crowns of the molars are quite low, and there is only a small quantity of cement in the valleys between the ridges.

In *Elephas* (*Stegodon*) *bombifrons* and *E. insignis* (fig. 22), which represent the next stage, the transverse ridges are somewhat more numerous and at the same time are higher, and the

Fig. 22.



Vertical longitudinal section of molar tooth of *Elephas* (*Stegodon*) *insignis*. From Lower Pliocene, Siwalik Hills, India. Showing the wide valleys between the cross-ridges filled with cement (*a*), the dark band marked *b* being the enamel, and beneath that the dentine (*c*). $\frac{1}{3}$ nat. size.

valleys are filled with cement to a greater degree. Nevertheless these differences are not very marked, and in the case of individual teeth it is often difficult to be sure to which of these

Stand J. species they belong. In some of the Stegodont elephants the tusks attain an enormous size; for instance, in a skull of

Fig. 23.

Skull and mandible of *Elephas ganesa*, showing the immense upper tusks and the shortened chin. From Lower Pliocene, Siwalik Hills, India. About $\frac{1}{32}$ nat. size.

Elephas (*Stegodon*) *ganesa* (fig. 23), exhibited in the gallery (stand J), the tusks project for a distance of 9 ft. 9 in. beyond the sockets.

Pier-case 34. In the next stage we pass from the low-crowned Stegodont

Fig. 24.

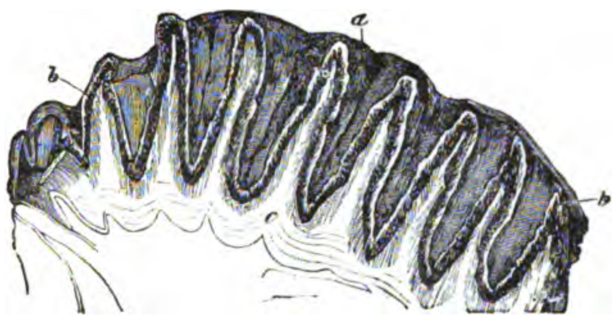
Grinding surface of an incomplete upper molar of *Elephas planifrons*. From Lower Pliocene, Siwalik Hills, India. $\frac{2}{3}$ nat. size.

group to animals in which the ridges are considerably higher and the valleys completely filled with cement; this is called the Loxodont group. The most primitive member is *Elephas*

planifrons (figs. 24 & 25), in which the posterior molars may have as many as twelve ridges. This is the last of the elephants in which premolars have been observed; these teeth are small and

Pier-case 84. Table-case 24.

Fig. 25.



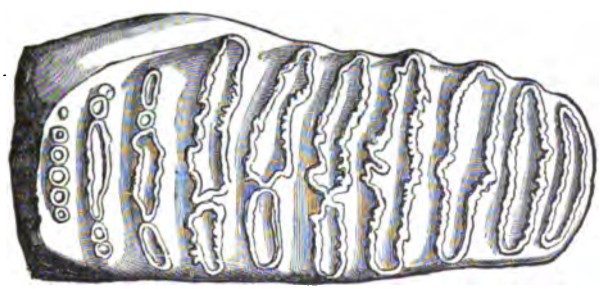
Vertical longitudinal section of molar tooth of *Elephas planifrons*, showing the deeper and narrower valleys completely filled with cement (*a*). The enamel layer is marked *b*, the dentine *c*. $\frac{1}{3}$ nat. size.

closely crowded up beneath the milk-molars, so that when those teeth are greatly worn the premolars are exposed to view, and are no doubt shed as soon as, or even before, the posterior part of the milk-molars they should replace.

The species *E. meridionalis* (fig. 26), of which remains are

Pier-case 33. Table-case 20.

Fig. 26.



Grinding surface of upper molar of *Elephas meridionalis*. Upper Pliocene, Tuscany. About $\frac{1}{3}$ nat. size.

found in the Pliocene of Middle and South Europe, seems to be closely related to *E. planifrons*, and is in about the same stage of

Pier-case 33. Table-case 20. evolution, or perhaps a little more advanced. The last mola may have 13–14 ridges, and in some cases approach the conditio seen in *E. hysudricus*. *E. meridionalis* attained enormous dime sions, some individuals probably standing about 15 feet in heig at the shoulder. Remains of this species occur in the Fore Bed of Norfolk (see table-case 20) and in the Upper Plioce deposits of the Val d'Arno and the Auvergne. According Leith Adams ('British Fossil Elephants,' p. 232) the molars a distinguished by the following characters:—"Crowns very broa columns short as compared with *E. antiquus*, and generally compared with *E. primigenius*; the enamel of the discs thic and rarely crimped, but usually uneven, looped or channelled plates wide apart, with thick wedges of cement." Numero teeth of this species are shown in table-case 20.

Pier-case 33. Returning to the Indian series, the next stage may be tak as represented by *Elephas hysudricus*, in which there is a co siderable increase in the height of the teeth and in the numb of the ridges. The skull is in many respects similar to th of *E. maximus*, the modern Indian elephant, which may ha been its direct descendant. *E. hysudricus*, like *E. meridional* sometimes attained a very large size. This species occurs the end of the Pliocene and perhaps in the early Pleistoce

Fig. 27.

Grinding surface of second lower molar of *Elephas antiquus* from the Pleistocene of Grays, Essex. $\frac{1}{3}$ nat. size.

Pier-case 33. Table-cases 19, 19A. beds of the Narbada. Contemporary with it was *E. antiqu* (fig. 27), a large elephant found in the late Pliocene and ear Pleistocene of Europe, and appearing in beds of the latt horizon of India, where it has been called *E. namadicus*. I this species the skull is peculiar from the development of

sort of overfolded ridge on its frontal portion, forming an overhanging fold on the forehead (see pier-case 34). The presence of this peculiarity makes it very unlikely that any of the later forms in which it is absent were descended from this species, which is of particular interest because it was very widely distributed. In the changes that took place in the distribution of land and water at the end of the Pliocene and the beginning of the Pleistocene, portions of the regions inhabited by this form and its varieties became isolated as islands, and in these restricted habitats the species became dwarfed and the dwarf forms in the different islands at the same time became specifically distinct from one another. Instances of these small forms are *Elephas melitensis*, *E. mnaidriensis*, *E. cypriotes*, and *E. creticus*. *E. melitensis* and *E. mnaidriensis* are found in Malta. Of the first-named species a small form sometimes called *E. falconeri* did not stand more than about three feet high at the shoulder. The ridge-formula of the molar teeth is:—M 1 $\frac{8-9}{8-9}$, M 2 $\frac{10}{10}$, M 3 $\frac{12-13}{12-13}$. A large collection of remains of these species, obtained by Admiral Spratt and Professor Leith Adams, is shown in table-cases 21 & 21 A. *E. mnaidriensis* is also found in Sicily; probably this species, which is larger than *E. melitensis*, represents the intermediate stage between it and *E. antiquus*. *E. cypriotes* from Cyprus, and *E. creticus* from Crete, were both discovered and described by Miss D. M. A. Bate, who collected the specimens shown in table-case 17 A.

Pier-case 34.

Table-cases 17 A, 21, 21 A.

Turning again to the main line, we find that *Elephas hysudricus* probably passed into some such species as *E. armeniacus*, which in many respects is intermediate between the Mammoth (*E. primigenius*) and the living Indian Elephant (*E. maximus*). The Mammoth seems to represent the highest pitch of evolution attained in the Elephantidæ, being in some respects in advance even of the Indian Elephant. It is here that we meet with the greatest number of ridges in the molars (fig. 28), the formula being M 1 $\frac{9-15}{9-15}$, M 2 $\frac{14-16}{14-16}$, M 3 $\frac{18-27}{18-27}$. These teeth represent the culmination of the long series of changes above described, all tending to increase the efficiency of the molars

Table-case 17.

Pier-cases 30–32. Table-cases 17–19.

as grinding organs. The great size, and especially height, of the crown gives them a prolonged period of wear, while the numerous alternating plates of enamel, dentine, and cement, of different degrees of hardness, ensure that the grinding

Fig. 28.

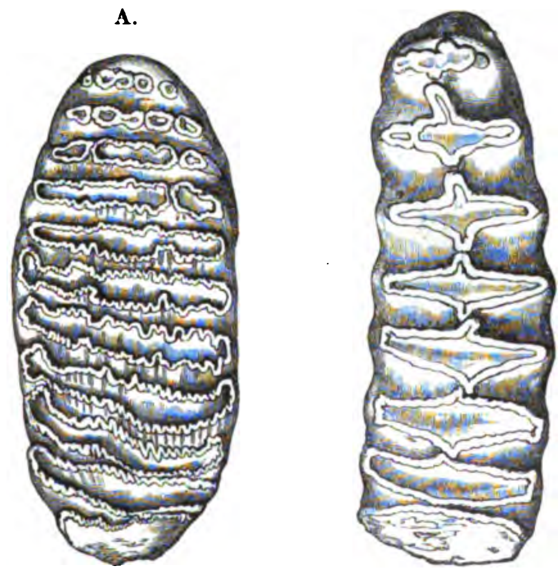
Grinding surface of molar tooth of the Mammoth (*Elephas primigenius*), showing some still unworn posterior plates. About ½ nat. size.

surface will remain sufficiently rough for its purpose throughout the period during which the tooth remains in use. The Mammoth was a very widely-distributed form, being found all over Northern Europe, Asia, and America, and it seems to have been particularly abundant in Siberia and the islands to the north, where remains occur in great abundance, and whence the tusks are actually exported for commercial purposes. The extinction of the Mammoth appears to have been a comparatively recent event, and in Siberia portions of carcases with the skin and flesh in good preservation are found in the frozen tundras. An instance of this kind is illustrated by drawings and photographs on the pillar between pier-cases 31–32. In this instance the animal seems to have fallen into a hole and to have died in its efforts to scramble out. The mouth was found still filled with the grass on which the animal was browsing at the time when it met with the accident. This individual, restored and mounted in the attitude in which it was found, is now exhibited in the Imperial Academy of Sciences at St. Petersburg. This specimen, with many others, shows that the Mammoth was covered with a reddish-brown wool and long dark hair, while the tail ended in a large tassel of hair. A

piece of the skin with its woolly covering and some of the long hair are shown in pier-case 31. Further confirmation of this peculiarity of the Mammoth is found in the rude sketches scratched on ivory by early Man, who was evidently quite familiar with the animal. A reproduction of one of these early drawings is shown near wall-case 1. Pier-case 31.

The finest Mammoth skull hitherto collected in England is shown in case K: this specimen was obtained from the brick-earth at Ilford in Essex. Most of the skeleton seems to have been found with it, but the bones were unfortunately destroyed before their interest was recognised. The tusks in this skull are 10 feet 6 inches in length beyond the sockets. Case K.

Fig. 29.



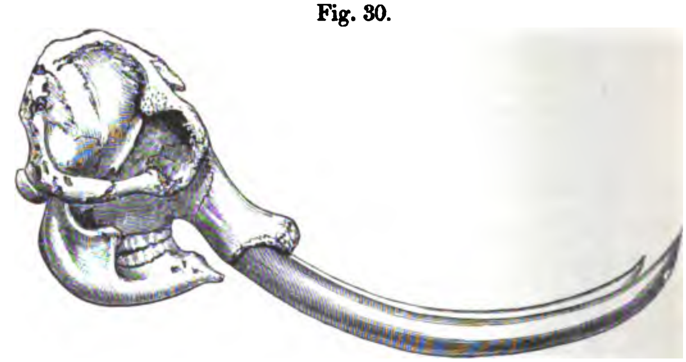
Grinding surface of upper molars of (A) the Asiatic, and (B) the African Elephant. About $\frac{1}{3}$ nat. size.

The Indian elephant, *E. maximus* (fig. 29 A), one of the two surviving species of the suborder, is found in India, Ceylon, and the Malay Peninsula to Sumatra. The chief peculiarities of the species, distinguishing it from the African elephant, are Stands D, E.

Stands D, E.

the flatness of the forehead, the comparatively small ears, the presence of a single finger-like process at the front of the end of the trunk (fig. 31 A), and the presence of four or five nails on the hind feet. As might be expected from the wide range of this species, different local forms can be distinguished, and in some cases these have even been regarded as specifically distinct, as, for instance, the elephant of Sumatra, which has been called *E. sumatranus*. It seems, however, that all are merely geographical races of the same animal. The Ceylon form is said to be as a rule tuskless, and although tusk-bearing forms do occur in the island, they may be either animals imported from the mainland of India or the result of former interbreeding with such. In India, also, some individuals, called Muchnas, are tuskless or have very small tusks (see mounted skin, stand E). The Sumatran type differs in being rather more slightly built, and in possessing a rather longer trunk and more expanded end to its tail. The elephants from Further

Fig. 30.



Skull of the African Elephant (*Elephas africanus*). About $\frac{1}{18}$ nat. size.

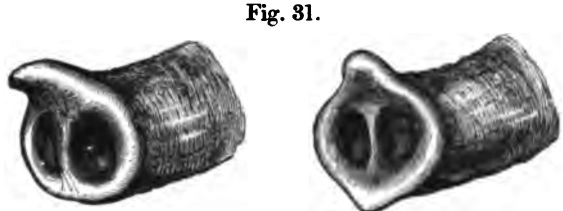
India and the Malay Peninsula are probably also a distinct race which seems especially liable to produce albino forms the white elephants of Siam and Burma being well known.

The origin of the other living species of elephant, *Elephas africanus* (fig. 30), is not very clearly known, owing to the want of fossil remains in the later Tertiary beds of Africa. It appears probable that the narrow-toothed, straight-tusked form of *E. antiquus* was either the ancestor, or nearly allied to the

ancestor, of the African Elephant, a conclusion that is supported by the recent discovery in Zululand, in beds of probably late Pliocene age, of a molar which is very similar to some molars of *E. antiquus*. This Zululand species has been called *Elephas zulu*, and was found associated with remains of other mammals, the first Tertiary mammalian fauna hitherto discovered in South Africa.

The African Elephant to-day ranges very widely over Africa south of the Sahara, but fossil remains have been found in Northern Africa and in the south of Europe. It is distinguished by its convex forehead, its very large ears, and by the presence of *two* finger-like processes on the tip of the trunk (see fig. 31 B). The molar teeth are considerably simpler than those of the Indian species (see fig. 29 B), the ridges being Central Hall.

Fig. 31.



Tip of trunk of (A) the Asiatic and (B) the African Elephant.

fewer in number and widening out in the middle in a peculiar manner; the teeth also are relatively smaller than in other elephants. In fact if, as is almost certain, *E. africanus* is derived from some such species as *E. antiquus* or *E. zulu*, then the changes that the molars have undergone are not in the same direction as those which gave rise to the Indian Elephant and the Mammoth, but are to some extent retrograde.

It has lately been shown that although there is only a single species of African Elephant, nevertheless, in different parts of the continent, there are different local races which may perhaps be regarded as subspecies, and are in fact species in the making. Differences in the form of the skull of these different races can be detected, but the most striking characters distinguishing them from one another are the size and shape of the ears.

Central Hall.

According to Mr. Lydekker the distinctive features of these local races are :—

I. In the Addo Bush, or East Cape, Elephant (*Elephas africanus capensis*) the ears are rather small, somewhat square in shape, with rounded corners, and a small, sharply pointed angular lappet at the lower angle. The forehead falls away towards the temples, so as to appear highly arched.

II. The West Cape Elephant (*E. a. toxotis*) has the ears much larger (4 ft. 5 in. in a female 8 ft. 8 in. high), longer, and semi-oval in shape; although, as in the preceding race, sharply inflected at the lappet.

III. In the Matabeleland race (*E. a. selousi*) the ear is much less elliptical than in the West Cape Elephant, and approaches more to that of the Camerun race, but agrees with that of the former in that the lappet underhangs the jaw and chin.

IV. In the West African Elephant (*E. a. cyclotis*), typically from South Cameruns, the ears are very large, but of quite different shape, the contour being oval, and the lappet in the form of half-ellipse. The skin has a mosaic-like appearance, and its colour is paler grey than in most other races. The Congo Elephant, which comes very close to this type, has long and slender tusks.

V. The Masai Elephant (*E. a knochenhaueri*), typically from German East Africa, has small triangular ears, with the lappet angulated and pointed. The exhibited specimen (which stands 11 ft. 4 in. in height, with ears measuring 4 ft. 2½ in. by 3 ft. 5 in.) may belong to this race.

VI. In the Aberdare Elephant (*E. a. peeli*), typically from the Aberdare Mountains, British East Africa, the ears are pear-shaped, with the lappet very long, although somewhat rounded at the tip.

VII. The Lake Rudolf Elephant (*E. a. cavendishi*) is nearly allied to the last, but has broader ears, in which the lappet is shorter.

VIII. In the Abyssinian, or Sudan, Elephant (*E. a. oxyotis*) the ears form an elongated triangle, with the upper border rounded and the lappet very sharply pointed and angular. This elephant attains very large dimensions.

IX. The N. Somali Elephant (*E. a. orleansi*), on the other hand, is small, with the upper border of the small ears straight, and the lappet short and distinctly defined. Central Hall.

X. In the West Sudan Elephant (*E. a. rothschildi*) the ears are in some respects intermediate between those of the Abyssinian and those of the West African race, although approximating to the former in the shape of the lappet.

There is also a dwarf elephant from the Congo (*E. a. pumilio*). The Albert Nyanza Elephant has been separated as *E. a. albertensis*, and is characterised by the unusually short and broad skull.

RELATIONSHIPS OF THE PROBOSCIDEA.

The discovery of the Eocene Proboscidea proves that, although the elephants are no doubt rightly included among the Ungulata or hoofed-animals, they are at the same time very widely separated from the other members of that group, or at least from the existing members of it, and seem to have formed an independent series from the earliest Tertiary times, when they probably arose from some quite generalised form of the primitive group called the Condylarthra. A very early side-branch from the Proboscidean stem is probably represented by the Sirenia or Sea-cows, aquatic animals which, though now as unlike elephants as possible, still possess a number of anatomical peculiarities in common with them, so that this relationship was recognised long ago. Recently a number of Sirenians have been found in the Eocene strata of Egypt (pier-case 30), one in the same horizon as *Moeritherium*. These early Sirenians are much less specialised than the existing forms, having the full series of teeth and a complete pelvis, and probably a functional hind limb. In many points they resemble *Moeritherium*, as for instance in the form of the brain, teeth, and pelvis; and it seems likely that both they and *Moeritherium* had a common ancestor in Lower Eocene times. It was probably a swamp-living creature, some of whose descendants became gradually more and more exclusively aquatic in their habits, thus giving rise to the Sirenia, while others became Pier-case 30.

exclusively terrestrial and gave rise to the elephants as described above.

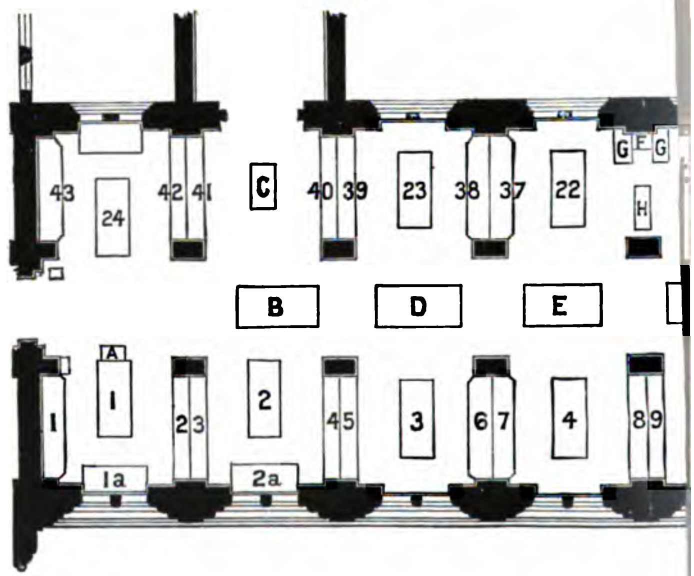
TABLE SHOWING THE RIDGE-FORMULA OF THE TRUE MOLARS IN THE APPROXIMATE LINE OF DESCENT OF THE ELEPHANTS FROM *Moeritherium*.

	M 1.	M 2.	M 3.
Moeritherium	$\frac{2}{2}$	$\frac{2}{2}$	$\frac{2}{3}$
Palæomastodon	$\frac{3}{3}$	$\frac{3}{3}$	$\frac{3}{3}$
Tetrabelodon angustidens	$\frac{3}{3}$	$\frac{3}{3}$	$\frac{4-5}{4-5}$
" *longirostris*	$\frac{4}{4}$	$\frac{4}{4}$	$\frac{5-6}{5-6}$
Mastodon cautleyi	$\frac{4}{4}$	$\frac{4}{4}$	$\frac{5}{5}$
" *latidens*	$\frac{4}{4}$	$\frac{4-5}{4-5}$	$\frac{5-6}{5-6}$
Elephas (Stegodon) cliftii	$\frac{6-7}{?}$	$\frac{6}{?}$	$\frac{7-8}{7-8}$
" " *bombifrons*	$\frac{6}{7}$	$\frac{6-7}{7-8}$	$\frac{8-9}{8-9}$
" " *insignis*	$\frac{7-8}{7-10}$	$\frac{7-8}{8-12}$	$\frac{9-11}{9-13}$
Elephas planifrons	$\frac{7}{7}$	$\frac{8-9}{8-9}$	$\frac{10-12}{10-13}$
" *hysudricus*	$\frac{9-12}{9-12}$	$\frac{10-12}{12-13}$	$\frac{13-17}{14-18}$
" *indicus*	$\frac{12}{12}$	$\frac{16}{16}$	$\frac{24}{24-27}$
" *primigenius*	$\frac{9-15}{9-15}$	$\frac{14-16}{14-16}$	$\frac{18-27}{18-27}$

A series of specimens illustrating the gradual increase in the number of ridges on the molars is shown in table-case 24.

Printed by TAYLOR and FRANCIS, Red Lion Court, Fleet Street.

B.M. GUIDE FOSS. MAMM. AND BIRDS



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Ratite Birds. 26. Edentata. 27. Marsupialia. 28. Proboscid
Proboscidean Ungulata. 30-43. Proboscidean Ungulata.

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tivora, and Chiroptera. 4-11. Ungulata. 12, 12a, 13, 13a.
14b, 15a. Edentata. 16. Rodentia. 17-21. Proboscidean Ungula

6

A GUIDE

TO THE

FOSSIL MAMMALS AND BIRDS

IN THE DEPARTMENT OF

GEOLOGY AND PALÆONTOLOGY

IN THE

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

WITH 6 PLATES AND 88 TEXT-FIGURES.

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CLASS II.—AVES (Birds).

LIST OF PLATES.

LIST OF ILLUSTRATIONS IN TEXT.

PREFACE.

SINCE the last edition of the "Guide to Fossil Mammals and Birds" was published in 1896, the additions to the collection have been so numerous, and knowledge has advanced so much, that the book has now been entirely re-written by Dr. Arthur Smith Woodward, the Keeper of Geology. The present issue, however, retains all the original features of the Guide, and is not in any sense a systematic treatise. Its arrangement is determined by that of the cases and specimens, and it sometimes refers to trivial details which are of interest solely to visitors actually in the Galleries.

As fossils can only be understood by those who have some acquaintance with the existing world of life, this Guide assumes on the part of the reader at least as much elementary knowledge as is contained in the Guides to the Department of Zoology.

Many of the specimens bear small discs of green or red paper. Those marked with green discs are either "type-specimens," or have been described and illustrated in some scientific work, to which a reference is given on the label. Those marked with red discs have been merely noticed or briefly described in print.

E. RAY LANKESTER,

Director.

May, 1904.

INTRODUCTION.

OBJECTS much resembling fishes, shells, plants, and other remains of living things, have been noticed in rocks from time immemorial. So long ago as the fifth century, B.C., the philosopher Pythagoras seems to have observed sea-shells buried in the earth far away from the shores of the seas then existing; while Xenophanes of Colophon recorded the discovery of fishes and other animals embedded in the hard rock of the quarries near Syracuse. Herodotus afterwards referred to sea-shells from the stone quarries in the hills of Egypt and the Libyan desert. Other contemporary philosophers and writers made similar observations, and most of them appear to have reached the very natural conclusion, that these petrified relics were originally buried in the bed of the sea, which had hardened and become dry land through the retreat of the waters.

At this early period in the study of natural philosophy, however, it was a common belief that animals could originate from the mud or slime of lakes and rivers. There was therefore another reasonable explanation of their occurrence as petrifactions in stone which seemed simpler, because it did not involve any startling theories as to great changes in the relations of land and sea. If certain animals could be generated in mud, it appeared quite probable that they should sometimes remain concealed in their native element without reaching the surface, and in that case they would become hardened into stone itself. As Theophrastus remarked concerning petrified fishes, they might have "either developed from fresh spawn left behind in the earth, or gone astray from rivers or the sea into cavities of the earth, where they had become petrified." These bodies thus appeared to be mere curiosities, and they were treated as such by Aristotle,

who was content to regard them as pro plastic force in the rock which he could not

The authoritative opinion of Aristot universally accepted by the few writers who subject before the revival of learning toward of the sixteenth century. By this time the teeth, and fish-remains met with in the st Italy had induced several observers in t reconsider the question of their true na discoveries in other European countries w discussed in their bearing on the same problem found in stone were now closely compared teeth, and skeletons of the animals most ne them which still lived in the Mediterran plant-remains were also studied deeply in the leaves of the known existing vegetation. that, although many observers still adhered prevalent belief, some of the most philosophi compelled by strict reasoning to admit th (Latin, "things dug up"), or fossils, as t commonly termed, were really the remains of animals and plants which they appeared Leonardo da Vinci, the well known painter, first to support this opinion with unanswera while Steno, a Professor in the University than a century later, made it impossible any his demonstration of the facts. Steno's acquired by the English Gresham Professor, J who bequeathed it to the University of Caml is still preserved in the Woodwardian Museum

The true nature of fossils was thus beginning of the eighteenth century, and th was to explain how the remains of sea-ani buried in the rocks far inland and at great hills and mountains. For at least sixty ye prevailing opinion that all the phenomena coul for by the Deluge recorded in the Pentateuch however, many difficulties in accepting thi and the discussions at the time led to a most of the manner in which the fossils were distributed in the different kinds of rock. accumulated at a remarkable rate, until, by eighteenth century, it became quite clear tha animals and plants could not have lived all t

time, but belonged to many different periods of the earth's history. Their destruction and burial, therefore, could not be ascribed to any single great catastrophe. It was demonstrated that during past ages the distribution of land and sea, mountains and plains, had frequently changed—that, in fact, rain, rivers, waves, currents, volcanoes, and phenomena like earthquakes, were continually altering the earth's surface, even under the eyes of man himself. The fossils were proved in most cases to be buried in displaced portions of sea-bottom, and in the mud of dried-up lakes; and it was realised that the relative ages of these deposits could be determined by the order in which they lay one upon another. Thus arose the true "science of the earth," which was named **Geology** by De Luc in 1778.

An English civil engineer, William Smith (1769–1839), was perhaps the first to realise fully the possibilities of this new branch of learning. His profession necessitated much travel through the country, and his interest in the distribution of fossils in the different kinds of rock led him to make a large collection, which was acquired by the British Museum in 1816, and is now exhibited in Gallery No. 11 of the Department of Geology. His published maps and writings prove that the various features of the landscape, in districts where fossils occur, are naturally carved out of layers of rock, which are simply old sea-beds or lake-beds piled one upon another, the oldest at the bottom, the newest at the top, each containing its own definite and invariable set of fossils. They also show that in most cases when these old sediments were raised into dry land, they were tilted in various ways from their originally horizontal position; so that it is often possible in a short walk to pass over the cut edges of many successive layers, perhaps hundreds of feet in thickness, representing immense periods of time.

While Smith and others were busily engaged in collecting fossils and observing their distribution, Blumenbach, Cuvier, Lamarck, Brongniart, and other naturalists were occupied with a detailed study of the fossils themselves. They soon demonstrated that, while most of these petrified remains could be interpreted by comparing them with the life of the present world, a large proportion represented animals and plants no longer existing. They also observed that the older the fossils, the more strikingly different they were from any animals and plants now living. It therefore became evident that fossils afforded a means of discovering

the past history of life on the earth—of
gradual stages by which our present ani
have become what they are, and have assun
geographical distribution. Thus was attain
of ancient life," which was named **Pa**
H. D. de Blainville and Fischer von Waldh

The Department of Geology in the
chiefly deals with fossils from the latter po
attempts to explain the main features in
Present by reference to that of the Past.

Note to the Geological Time-scale.—The names in
to the left are applied only to periods of time. The
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periods opposite which they are placed. These strata
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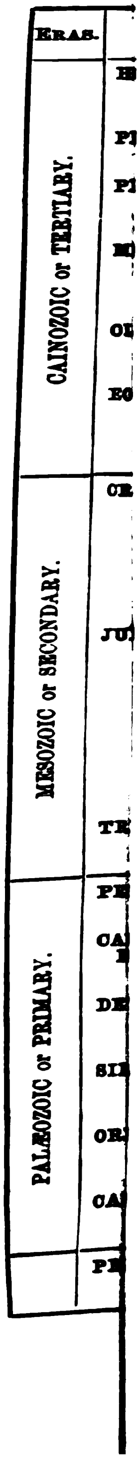
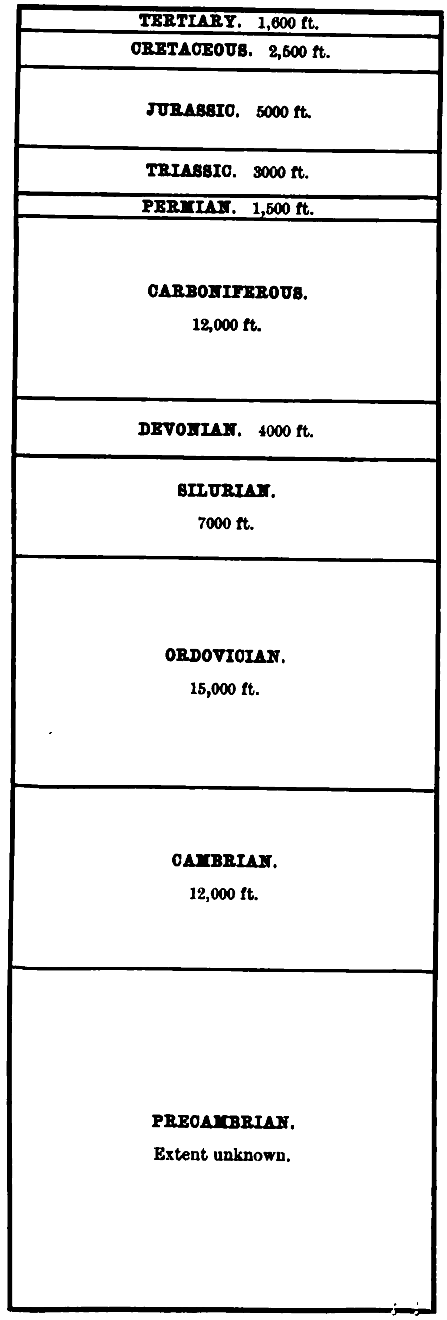
N.W. Europe.

[To be inset by this edge opposite p. xvi.]



RELATIVE LENGTHS OF EPOCHS.



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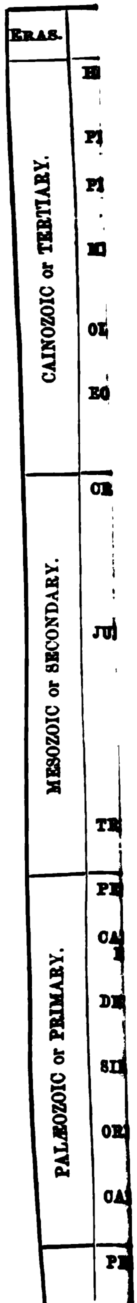

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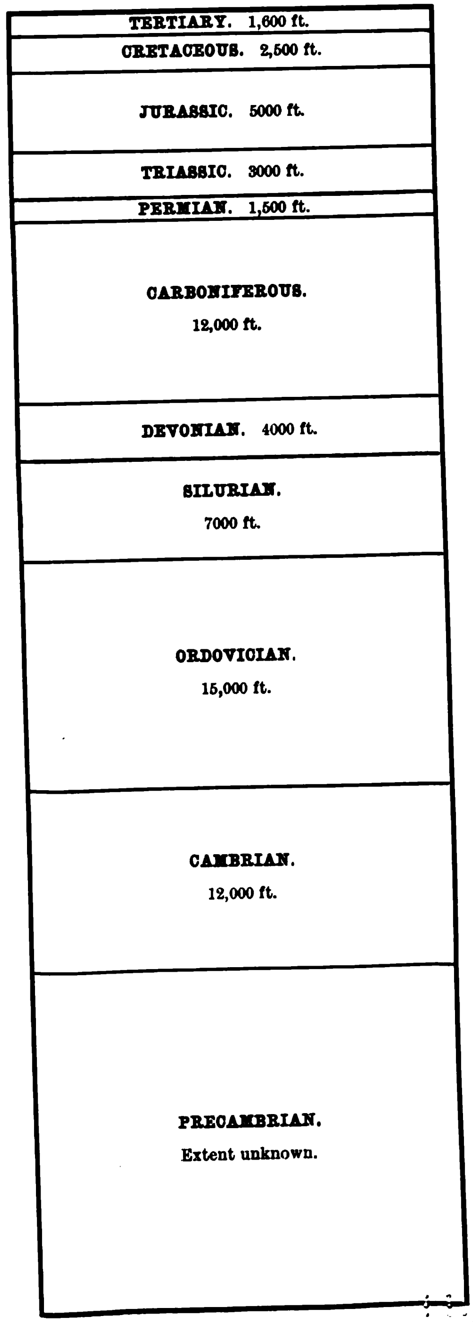

A GUIDE

TO THE

FOSSIL MAMMALS AND BIRDS.

GALLERIES Nos. 1, 2.—FOSSIL MAMMALIA.

THE Mammalia, or warm-blooded quadrupeds which nourish their young with milk, are so modern, geologically speaking, that most of their fossil remains occur in comparatively superficial deposits where they have not been much petrified or mineralised. A large proportion of the fossil bones of this Class thus appear almost as fresh as those of newly-prepared skeletons, being merely stained by the sand or mud in which they have been buried. Some of the bones, from the most recent deposits and Pleistocene formations, are indeed changed only by the loss of their animal-matter, which causes them to become brittle and powdery; and when these are disinterred it is necessary to harden them by treatment with a solution of gelatine or glue, which often produces a shiny surface. Most of the bones from the sandstones, shales, and limestones of the earlier Tertiary formations, have their animal-matter replaced by silica and oxides of iron, which also fill their interstices and impart to these specimens a natural hardness.

The fossil Mammalia are arranged in the Galleries not according to their geological age but primarily in the natural groups recognised by zoologists. The extinct representatives of each Order are placed together, the various Sub-orders and Families being usually arranged in a descending scale from the highest to the lowest. This arrangement within the Order obviously corresponds more or less with the geological succession of its various representatives; for the higher groups occur later in time, the lower groups earlier.

The series begins on the right-hand sid
Gallery No. 1 and is continued round
left-hand side of the same entrance. The
of the Orders Edentata, Marsupialia, an
placed in Gallery No. 2. Many of the l
necessarily mounted on separate pedes
cases, not in their exact systematic posit
allied fossils as possible.

BONE-BEDS.

Case A.
Pier-case 2.

Most of the fossil remains of Mam
from "bone-beds" or great accumulatio
have been formed by the death and r
troops of animals, or by the washing tog
skeletons by streams and currents. In t
for example, there is an extensive bone-be
age, which seems to have resulted from
herds of quadrupeds by a fall of volca
neighbouring eruption. In Greece the
beds also of Lower Pliocene age, which
lated rapidly in lakes or temporary pools
excavated especially at Pikermi, near At
from one of them, presented by Mr. A
shown in a special Case A, near Table-c
specimen (Plates II, III) there are re
antelopes, gazelles, the three-toed hor
two birds, crowded together in red marl,
mud washed down from the neighbour
Pentelicon. Many of the bones are in
(as, for instance, those of one bent leg of
that parts of the skeletons were burie
the ligaments and muscles which held
decayed. At Olivola, in the Carrara M
is an Upper Pliocene torrent-deposit f
pebbles; and good examples of this are
(top shelf). In many places, in the de
there are great collections of bones b
eddying currents, such as those discove
the Thames during the working of bric
Crayford. There are also numerous fi
limestone districts, largely filled with ac
which have fallen or been washed into
bones are mingled with angular frag

Block of Lower Pliocene Marl from Pikermi, Greece, crowded with remains of Mammals and a few bones of Birds; about one-fifth nat. size. The central skull belongs to *Hipparion*, the surrounding bones to *Hipparion*, various antelopes, and one small carnivore. (Case A.)

[*To face p.* 2.

Block of Lower Pliocene Marl from Pikermi, Greece, crowded
side of specimen shown in Plate II.). The bent hind li
conspicuous, surrounded by other bones of this animal
bird-bones below. (Case A.)

cemented together by carbonate of lime, they are termed "bone-breccias" (Italian *breccia*, a crumb). Examples are shown from Gibraltar, from Minas Geraes, Brazil, and from the Wellington Caves, New South Wales (Pier-case 2, top shelf). Treacherous ground, like a swamp or peat-bog, is often rich in the skeletons and other remains of animals which have become mired by accident. The salt marshes or "licks" of North America thus yield remarkable skeletons of the mastodon (Stand B), while the tundras of Siberia entomb innumerable carcases of the mammoth and woolly rhinoceros. **Pier-case 2.**

Caverns.

The bone-bearing deposits on the floors of caverns in limestone districts are particularly interesting, because in many cases the fossil remains have not been introduced by accident, but by men or wild beasts which have inhabited these retreats. In England and Wales, for example, a large proportion of the caverns were hyæna-dens during the Pleistocene period, and the remains both of the hyænas and of their prey are found in the red clay covering the floor. Other caverns were inhabited by primitive man, either exclusively by him or only at times when the hyænas were driven out; and in such cases there are articles of human workmanship, traces of fire, and even bones of man himself, in the same kind of deposit. This "cave-earth," as it is termed, is mainly the residue of decomposed limestone, and it is mixed with drippings of lime-water, which evaporate and leave a crust of carbonate of lime. When a cavern becomes deserted and the drippings are undisturbed, the limy crust thickens slowly into a layer of "stalagmite," which seals up whatever may be beneath in a permanent state of preservation. A specimen of the resulting floor from Brixham Cave, near Torquay, enclosing an antler of a reindeer, is seen in Wall-case 1. An interesting piece of stalagmite enclosing human remains, from the cavern of Bruniquel, France, is also shown in the same case. **Wall-case 1. Pier-case 2. Table-case 1.**

Mammals of Pleistocene Europe.

Unfortunately, the surface of the land changes so rapidly by weathering and "denudation" (natural wearing down and washing away), that no once-inhabited caverns hitherto discovered date back further than the Pleistocene period.

Wall-case 1. Pier-case 2. Table-case 1. For this comparatively modern geologica they have furnished a nearly complete races and the animal life inhabiting least; and a typical collection of remai story is exhibited in Wall-case 1, Pier-c and two adjoining special frames.

Pier-case 2. The western portion of continental Eu cene period included the British Isles, wh time been separated from the mainlan extent of the land is shown by a map on Pier-case 2. The hollow at present occu Sea would then be a wide valley or p rivers flowed; and it was inhabited by whose remains lie scattered in abundan Bank and other portions of the existin These bones and teeth are continually fishermen, and a typical series of them, of Mr. J. J. Owles, of Great Yarmouth, case 2. Here there is evidence of wolf, ox, bison, an extinct fallow-deer (*C. brown* deer, elk, horse, woolly rhinoceros, and the specimens were doubtless originally and gravels deposited by the rivers, the washed out by the scour of the tides an have lain for some time exposed on the by the remains of serpulæ, oyster spat, organisms upon them.

Wall-case 1. Pier-case 2. As proved by the fragmentary bones in Wall-case 1 and Pier-case 2, the Br evidence of a remarkable series of mam in this part of Europe during the Pleis being now confined to the Arctic Re Tropics, others still living here, and extinct. The complete list (except rat follows:—

Northern and Arctic Mamm

Glutton (*Gulo luscus*).
Arctic Fox (*Canis lagopus*).
Reindeer (*Rangifer tarandus*).
Lemming (*Myodes lemmus* and *Cunic*
Pica (*Lagomys pusillus*).
Marmot (*Arctomys marmotta*).
Souslik (*Spermophilus erythrogenoide*

Wall-case 1.
Pier-case 2.

TEMPERATE MAMMALIA.

Wild Cat (*Felis catus*).
Lynx (*Felis lynx*).
Otter (*Lutra vulgaris*).
Badger (*Meles taxus*).
Stoat (*Mustela erminea*).
Weasel (*Mustela vulgaris*).
Marten (*Mustela martes*).
Fox (*Canis vulpes*).
Wolf (*Canis lupus*).
Brown Bear (*Ursus arctos*).
Grisly Bear (*Ursus horribilis*).
Horse (*Equus caballus*).
Bison (*Bison bonasus*).
Roebuck (*Capreolus caprea*).
Stag (*Cervus elaphus*).
Wild Boar (*Sus scrofa*).
Hare (*Lepus europæus*).
Rabbit (*Lepus cuniculus*).
Beaver (*Castor fiber*).

SOUTHERN MAMMALIA.

Lion (*Felis leo*).
Leopard (*Felis pardus*).
Kaffir Cat (*Felis caffra*).
Spotted Hyæna (*Hyæna crocuta*).
Hippopotamus (*Hippopotamus amphibius*).

EXTINCT MAMMALIA.

Sabre-toothed Tiger (*Machærodus latidens*).
Short-nosed Cat (*Felis brevirostris*).
Cave-bear (*Ursus spelæus*).
Woolly Rhinoceros (*Rhinoceros antiquitatis*).
Narrow-nosed Rhinoceros (*R. leptorhinus*).
Large-nosed Rhinoceros (*R. megarhinus*).
Irish Deer (*Cervus giganteus*).
Urus (*Bos primigenius*).
Mammoth (*Elephas primigenius*).
Straight-tusked Elephant (*Elephas antiquus*).

The remains of some of these animals have an interesting distribution. The cave-bear occurs most abundantly in the oldest layer of the floor, as in Kent's Cavern and the Creswell Caves. It is the only animal found in some of the caverns of Franconia and the Harz Mountains, Germany, where most of the individuals are aged and seem to have retreated to these quiet spots to die. The British lion appears to have been most numerous in the neighbourhood of the Mendip Hills. The hippopotamus ranged as far north as Kirkdale Cave in the Vale of Pickering, Yorkshire. The

Wall-case 1. Pier-case 2. mammoth occurs chiefly in the hyæna-
represented only by the teeth of young
would be a much more ready prey than the
The hyæna-dens are easily recognised, n
abundance of the remains of the hyæna
also by their "coprolites" (or fossilised ex
gnawed bones of their prey. The toot
animals are often quite distinct; and the l
prey are usually represented only by the m
the ends having been gnawed away until
scoop out the whole of the marrow with th
good examples are exhibited from the B
Wood, Wookey, and Creswell Caves.

The old river-deposits in the valley of t
are contemporaneous with the lower cave
yielded remains of the same mammals as t
addition of the elk (*Alces machlis*), the
moschatus), and the saiga antelope (*Saiga*
will be referred to again when treating
collection.

Man Associated with Pleistocene

Table-case 1. During the whole of the Pleistocene
mammals just enumerated lived in western
undoubtedly present as a wandering hunt
his bones occur; but his implements of sto
occasional traces of his fires, are found in in
with the remains of the wild beasts. A fe
primitive implements are arranged in Table
drawers of an adjoining cabinet, which co
part of the late Sir Joseph Prestwich's colle

All the stone implements found in
deposits are of the "Palæolithic" or ancie
i.e., they are roughly chipped (not poli
broadest end would be grasped or fixed, whi
or pointed end would be used for chop
scraping. In the valley of the Thames,
places, these implements were of flint; and
on the river-bank where the Palæolithic
made his equipment have been discove
"floor," explored by Mr. Flaxman C. J. Sp
in Kent, is illustrated by a selection fro
in Table-case 1. Here are the flakes wh

away in trimming the flint-nodules to shape, and among them is a broken jaw of a woolly rhinoceros, which may possibly represent part of the workman's food. There are also completed implements. One example was accidentally broken before it was finished, and so thrown away. Mr. Spurrell recovered the two pieces, and also the numerous flakes which were struck off in the fashioning of it. With **Table-case 1.**

A

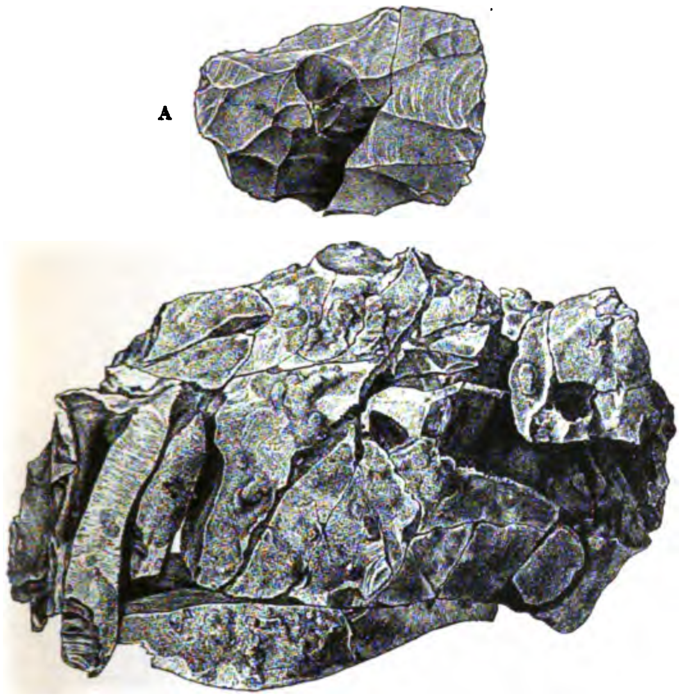

Fig. 1.—Block of Flint from Crayford, Kent, broken by Palæolithic Man in making an implement (A), which was never finished because it was accidentally fractured; one-third nat. size. (Spurrell Collection, Table-case 1.)

great patience and skill he replaced all the flakes, thus restoring the flint-nodule to the original form which it had when Palæolithic man selected it for his work (Fig. 1). **Table-case 1.**

The finest and most varied Palæolithic stone implements (flint or chert) are found with the bones of the Pleistocene mammals in the higher layers of the caverns. They denote a more advanced race of men, which Professor Boyd Dawkins

Table-case 1. has compared with the living Eskimo ments are supplemented by bone har awls, and even by well-made bone nee reindeer were doubtless used for sew just as they are employed by the Lapp present day. Pierced teeth were prob into necklaces and armlets. There are with outlines roughly portraying the a Examples of the stone and bone impl Cavern, Torquay, and from the French c Table-case 1. One incised reindeer antl from a French cavern displays the rough part of a horse. Plaster casts of m implements and outline sketches of the in a frame on the wall adjoining the win

This small selection of the handiw man is exhibited here merely to illus with the Pleistocene mammals. The both of Palæolithic and later workman Museum is placed in the Department of Antiquities at Bloomsbury, and is descri the Antiquities of the Stone Age," obta Museum, Bloomsbury, W.C.

The late Sir Joseph Prestwich and s have expressed the opinion, that there presence of man in western Europe at before most of our valleys were excav present drainage-system of our land wa evidence consists in rough pieces of flint, been chipped artificially along one or m have been used by man. These suppos first noticed by Mr. Benjamin Harriso plateau-gravels, probably of Upper Plic and many of his specimens are include Collection, of which the principal ser Table-case 1. They are termed "eoli believe that they represent the dawn o Man.

British Pliocene Mamm

Table-case 1a. Very little is known of the mam British area during the Pliocene peric represented by very fragmentary rem Pliocene Crag deposits of East Anglia,

satisfactory teeth and bones lately found in a fissure in the Carboniferous Limestone near Buxton, Derbyshire. A typical series of the Crag fossils is exhibited in Table-case 1A. *Mastodon*, *Hipparion*, *Tapirus*, *Gazella*, and *Hyænarctos*, are the most noteworthy genera. Some of the specimens may have been washed out of Miocene deposits. **Table-case 1a.**

SYSTEMATIC COLLECTION.

CLASS.—MAMMALIA.

SUB-CLASS I.—EUTHERIA.

ORDER I.—**PRIMATES.**

SUB-ORDER 1.—**Anthropoidea.**

Table-case 1. Pier-cases 2, 3.

As already mentioned, the bones and teeth of man are very rare in geological formations—he is usually represented merely by his handiwork. A few important specimens, however, have been discovered, and plaster casts of these are exhibited in Table-case 1. There is a copy of the top of a skull, of a very lowly type, found with the remains of Pleistocene mammals in a cavern in the Neanderthal, near Düsseldorf, Germany. There are also copies of two imperfect skulls and some limb-bones of a similar lowly kind of man discovered in undoubted association with Pleistocene mammals in the cavern of Spy, near Namur, Belgium. These specimens seem to represent a human race inferior to any now existing, but comprising powerfully built individuals. The forehead is low; the bony ridges above the eyes are very prominent; and the chin is somewhat retreating. The radius and ulna are unusually divergent in the middle of the fore-arm. The femur is somewhat bent, and the tibia is comparatively short, so that the leg cannot have been quite upright in walking.

Pier-case 2.

Most of the actual bones of man preserved in the collection are probably quite modern compared with the primitive race just mentioned. In Table-case 1 there are parts of the skeleton of an aged man found at a depth of 34 feet in the Thames mud during the excavation of Tilbury Docks. In Pier-case 2 is placed the famous human skeleton

Pier-case 2. fossilised in limestone, which was obtaine
Alexander Cochrane, R.N., from the island
near that of Guadaloupe in the West Ind
which this specimen was discovered is quit
formation.

Table-case 1. The oldest known traces of a man-lik
roof of a small skull, two grinding teet
femur, discovered by Professor E. Dubois in
ash containing remains of Pliocene mamm
Java. A plaster cast of the piece of skull i
case 1. It shows that the capacity of the
animal, which has been named *Pithecanth*
scarcely have exceeded two-thirds that of
The forehead is very low, and the bony
eyes are prominent.

Pier-case 3. The man-like apes or **Simiidæ,** which
the present day by the gibbons, orangs,
gorillas, in the tropics of Asia and Afri
southern Europe in the latter part of the M
characteristic thigh-bone of one of these
rhenanus) has been found in the lowest
Pliocene period even so far north as E
Darmstadt. All the fossil forms are know
of jaws and isolated limb-bones, of which
exhibited in Pier-case 3.

The Old World monkeys are proved t
Middle Miocene period in Europe. *Meso*
Lower Pliocene of Pikermi, near Athens, is
all parts of the skeleton, and fine skulls a
case 3. It is allied to the living Indi
Macacus, which still survives in Europe
Gibraltar, is represented by one molar toot
pliocenus by Owen) from the Pleistocene bri
Essex. No other evidence of a fossil monk
in Britain.

SUB-ORDER 2.—**Lemuroide**

Pier-case 3. The lemurs, which are evidently of a
the monkeys and apes, immediately preced
poidea both in Europe and North Amer
extinct, at least in Europe, as soon as the
They were quite abundant in both regions d
and Oligocene periods. Fine skulls and
Adapis and *Necrolemur,* which are typical

red Phosphorites of southern France, are shown in Pier-case 3. There are also jaws of the same animals from the Upper Eocene of Hordwell, Hampshire (Fig. 2), and jaws of an allied genus from the Eocene of Dakota, U.S.A. At the present day the lemurs are confined to Madagascar, parts of Africa and the southern Asiatic region. They are especially characteristic of Madagascar, and are all small animals adapted exclusively for a life in trees. In the surface deposits and caverns of Madagascar their fossil remains are numerous, and among these it is easy to recognise large and even gigantic extinct kinds (*Nesopithecus*, *Megaladapis*, etc.) which lived in the Pleistocene and Prehistoric periods. The largest species of *Megaladapis* (*M. insignis*), of which various fragments are exhibited and of which a restored

Pier-case 3.

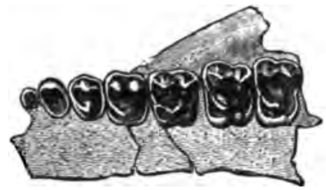

FIG. 2.—Palatal view of left upper teeth of a Lemur (*Adapis magna*) from Upper Eocene, Hordwell, Hampshire; nat. size. (Pier-case 3.)

FIG. 3.—Model of skull and lower jaw of a supposed aquatic Lemur (*Megaladapis insignis*), from a Cavern in Madagascar; one quarter nat. size. (Pier-case 3.)

Pier-case 3. model of the skull (Fig. 3) is placed on the top shelf of Pier-case 3, must have been about as large as a donkey. It clearly did not live in trees, and it may perhaps have been adapted for an aquatic life. The bony rims of the orbits are curiously produced and arranged like those of a hippopotamus.

ORDER II.—CARNIVORA.

SUB-ORDER 1.—Carnivora Vera.

Pier-case 3. The true cats or **Felidæ** are well represented among fossils, which trace back the ancestry of this highest surviving tribe of flesh-eaters to Miocene European animals much resembling the existing *Cryptoprocta* of Madagascar. *Felis* itself first appears in the Middle or Upper Miocene of Europe, and culminated in the great cave-lion, which is probably only a variety of the existing *Felis leo* of Africa and Asia. Among the numerous remains of this animal in Pier-case 3 may be particularly noticed the fine skull obtained by Mr. Flaxman Spurrell from the Pleistocene brick-earth of Crayford, Kent. The small ancestral Felidæ are represented by jaws of *Pseudælurus* and *Proælurus* from the Miocene of France.

Still more deadly than the Felidæ must have been the extinct **Nimravidæ** or **Machærodontidæ**, of which many were as large as lions, with over-grown upper canine teeth and with fore-limbs as effective as grappling irons. A diagram of a complete skeleton of *Machærodus* from the pampa of South America (now in the National Museum, Buenos Aires), is placed in the upper part of Pier-case 3, above the remains of this and the allied genera. *Machærodus* is often named the "sabre-toothed tiger," in allusion to its large, laterally-compressed upper canine teeth, which have finely serrated edges. The mouth seems to have opened to an abnormal extent to permit the effective use of these terrible weapons (Fig. 4). As shown by the fragmentary fossils, *Machærodus* is represented first in the Miocene of France and Germany; next in the Pliocene of France, England, Italy, Greece, Hungary, the Isle of Samos, Persia, and India; and finally by the largest species in the Pleistocene of France, Germany, Italy, England, North America, Ecuador, Brazil, and Argentina. Teeth from Kent's Cavern and the Creswell caves prove its association with the cave-

men in England. The complete extinction before historic times of so widely-spread an animal is very remarkable. *Hoplophoneus*, of which skulls are exhibited, is an allied **Pier-case 3.**

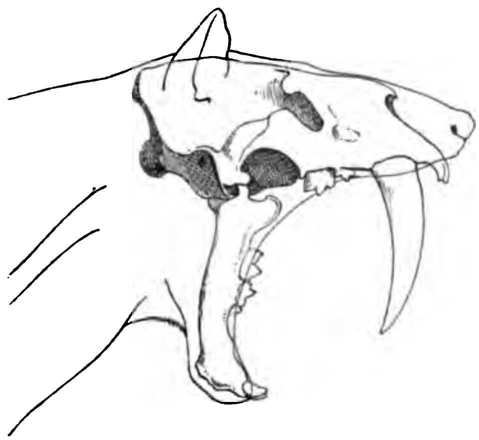

FIG. 4.—Diagram of head of the "Sabre-toothed Tiger" (*Machærodus neogæus*), from the Pampa Formation of Buenos Aires, Argentine Republic, showing the widely open mouth; one-eighth nat. size. (After W. D. Matthew.)

genus from the Oligocene White River Formation of North America. *Eusmilus*, represented by jaws, is one of the small ancestral forms from the Oligocene Phosphorites of southern France.

In the exhibition of remains of **Hyænidæ** (Pier-case 3) the largest space is occupied by the European cave-hyæna, which seems to have been essentially identical with the existing spotted hyæna (*Hyæna crocuta*) of Africa. Individuals in all stages of growth are represented by the jaws and teeth from the English caverns, and by other fragments from river deposits and the Norfolk Forest Bed. Other true hyænas are known by fossils from the Lower Pliocene of Greece, Samos, Persia, and India; but there are no traces of the family in America. *Ictitherium*, from the Lower Pliocene of Greece, Samos, Persia, and India, is known not only by fine skulls, of which there are some in Table-case 2, but also by the greater part of the skeleton. It is an ancestral genus, connecting the Hyænidæ with the Viverridæ. **Pier-case 3.** **Table-case 2.**

The **Viverridæ**, or civets, mongooses, and their allies,

Table-case 2. are very old Carnivora, which appear to have been always small animals confined to the Old World. As shown by remains in Table-case 2, *Viverra* itself seems to have lived unchanged from the Upper Eocene period to the present day.

The **Mustelidæ**, or weasels, badgers, and otters (Table-case 2), also date back to the Upper Eocene period, beginning in the Old World and then spreading to America. The occurrence of the glutton (*Gulo luscus*) in the English and Welsh cave-earths, and in the Forest Bed, is interesting.

The raccoons, or **Procyonidæ**, are scarcely known among fossils; but teeth from the Red Crag (Lower Pliocene) of Suffolk seem to belong to the existing Indian *Ailurus* or a closely allied genus (plaster cast in Table-case 2).

The **Canidæ**, or wolves, foxes, jackals and dogs, have scarcely changed in any essential respects since the Miocene period, when they already flourished both in the Old World and in North America. Murchison's famous "fossil fox of **Pier-case 3.** Oeningen," from the Upper Miocene of Baden, is a typical member of the family. *Cynodictis* and allied genera (Table-case 2), from the Oligocene Phosphorites and the Upper Eocene of France, connect the Canidae with the Viverridae.

Pier-case 4. Table-case 3. The bears, or **Ursidæ**, which are at present distributed over nearly all the world, except Australia and New Zealand, have only had so wide a range since the dawn of the Pleistocene period. So far as known, the family began its

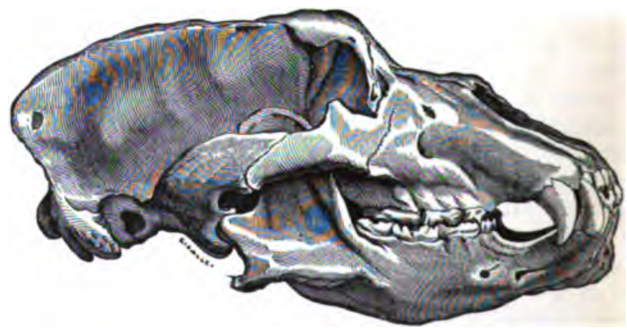

Fig. 5.—Skull and lower jaw of the Cave-bear (*Ursus spelæus*), from a Pleistocene Cavern Deposit in Bavaria; about one-sixth nat. size.

existence in Europe and Asia, where there are many remains of Pliocene, Miocene, and Oligocene animals which must be regarded as ancestors. The true bears of modern times are mixed feeders, and have teeth modified accordingly. In the

Pleistocene period an extinct species of very large size, whose remains are frequently found in the caverns of Europe, is named the cave-bear (*Ursus spelæus*). A skeleton, reconstructed from the bones of several individuals from French caverns, is exhibited in Pier-case 4. Remains of this species (Fig. 5) are common in the English and Welsh caverns, but it does not appear to have reached Ireland or North America. A curious snub-nosed bear (*Arctotherium*), also of large size, existed in the Pleistocene period in America; and a partially reconstructed skeleton of it, from the pampa of Buenos Aires, is mounted in Pier-case 4. In the Pliocene of Europe and Asia, and in the Miocene of Europe, there are bear-like quadrupeds with square (not elongated) upper grinding teeth (Fig. 6). A very large species, *Hyænarctos sivalensis*, from the Siwalik Formation of India, is represented by a fine skull and other remains in Pier-case 4. This animal seems to have differed from the bears and resembled the dogs in having a very prominent elbow. Older fossils from the Miocene and Oligocene of Europe, named *Amphicyon* and *Cephalogale* (Fig. 7), belong to animals

Pier-case 4.
Table-case 3.

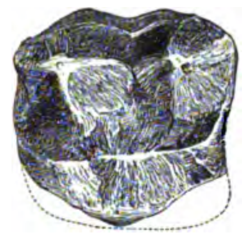

Fig. 6.—View of grinding surface of molar tooth of *Hyænarctos*, from the Red Crag of Suffolk; nat. size.

Pier-case 4.

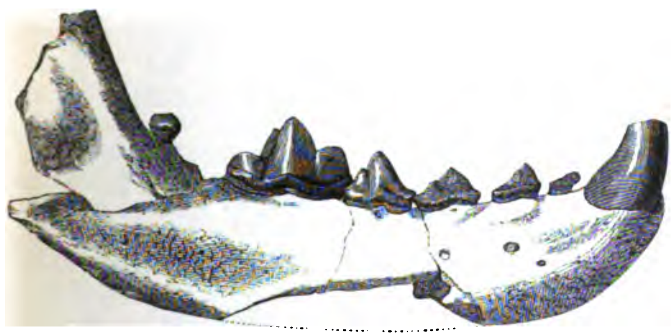

Fig. 7.—Right ramus of lower jaw of a primitive dog-like, bear-like Mammal (*Cephalogale brevirostris*), from the Oligocene Phosphorites of France; nat. size.

Table-case 2.

of a strictly flesh-eating kind, which were neither bears nor dogs, but intermediate between the two families. Good examples of the dentition are seen in Table-case 2.

SUB-ORDER 2.—**Creodonta.**

Table-case 2a.

The true Carnivora can thus be traced back to the Upper Eocene, when most of them were small creatures closely

FIG. 8.—Skeleton of a Creodont (*Hyænodon cruentus*), from the Oligocene of Dakota, U.S.A.; one-seventh nat. size. (After W. B. Scott.)

resembling the existing Viverridæ. They are preceded in the Middle and Lower Eocene, both in the Old World and

in North America, by peculiar lowly Carnivora with a comparatively small brain, in which the cerebral hemispheres are nearly smooth and do not cover the mid-brain. In these animals there is no special "sectorial" or "carnassial" (flesh-cutting tooth) near the back of the jaw, and the whole dentition is very similar to that of the flesh-eating pouched animals (Marsupialia) now living in Australia and Tasmania. They were, in fact, regarded as Marsupialia for many years, until it was discovered that some of them possessed a complete milk-dentition which was replaced by the usual permanent teeth. The existing Marsupialia never have more than one milk-tooth replaced on each side of either jaw. **Table-case 2a.**

These Creodonta ("flesh-teeth"), as they are termed, were sometimes as large as lions or bears, and survived in the northern hemisphere at least until the beginning of the Miocene period. A typical series of remains, chiefly of the Upper Eocene and Oligocene genera *Hyænodon* (Fig. 8) and *Pterodon*, is shown in Table-case 2A. A fine jaw of a large *Pterodon* from the Upper Eocene of Egypt is especially noteworthy.

The so-called **Sparassodonta** from the early Tertiary of South America seem to have been Creodonts in which only one or two of the premolars and the canine were preceded by milk-teeth. Portions of jaws of *Prothylacinus* and *Borhyæna* (plaster casts), from the Santa Cruz Formation of Patagonia, are exhibited in Table-case 2A.

SUB-ORDER 3.—**Pinnipedia.**

The seals, walruses, and their allies are scarcely represented among fossils, and no important ancestors are known. The tusks of a large walrus (*Trichecodon huxleyi*) have been found in the Pliocene Red Crag of Suffolk (see Table-case 1A). A few fragments of seals from the Norfolk Forest Bed are shown in Table-case 3; and with these are plaster casts of other remains from the Pliocene Crag of Belgium. **Table-cases 1a, 3.**

ORDER III.—**INSECTIVORA.**

Among the fragmentary fossil remains of the shrews, moles, and hedgehogs, there are none of much interest; but they date back at least to the close of the Eocene period. **Table-case 2a.**

Table-case 2a. Jaws and limb-bones of the desman (*Myogale moschata*), an animal now confined to south-east Russia, are shown from the Norfolk Forest Bed.

ORDER IV.—**CHIROPTERA.**

Table-case 2a. Fossil skeletons discovered in France prove that the bats were as completely formed in the Upper Eocene as they are at the present day; but there are only imperfect skulls and jaws in the collection of the Museum (Table-case 2A).

ORDER V.—**UNGULATA.**

As the hoofed animals are traced backwards through geological time, the fossils gradually lead to small marsh-dwelling or forest-dwelling predecessors, which were adapted to live on succulent vegetation. The existing tapirs, pigs, peccaries, hippopotamus, and chevrotains, are the least altered survivors of this ancestry; while the rhinoceroses, horses, cattle, giraffes, deer, and elephants, with effective grinding teeth, are the highest and newest members of the Order.

SUB-ORDER 1.—**Perissodactyla.**

Pier-cases 6–10. Table-cases 4, 5. It seems probable that at the dawn of the Eocene period all the hoofed animals were five-toed; but most of them soon began to exhibit a tendency towards the reduction of the spreading foot. In one group comprising the existing tapirs, rhinoceroses, and horses, the whole weight of the body gradually became concentrated on the middle toe, so that this grew stout at the expense of the other toes. Thus arose the uneven-toed hoofed animals or Perissodactyla. The tapirs retain four toes on the fore foot, three on the hind foot; the rhinoceroses, three toes on each foot; and the true horses, only one toe on each foot (see Fig. 9).

Pier-cases 6–8. Table-case 4. The **rhinoceroses**, which are restricted to Africa and the Indian region at the present day, wandered far from tropical climes during the Pleistocene period and ranged over nearly the whole of Europe and Asia, being common even within the Arctic Circle. The northern species (*Rhinoceros antiquitatis* or *R. tichorhinus*) seems to have been most closely related to the nearly extinct square-nosed rhinoceros (*R. simus*) of Africa. It is commonly known as

the "woolly rhinoceros," because its mummified remains, which are discovered in the frozen tundras of Siberia, prove that the skin was covered with wool and long hair. It possessed two horns, of which the foremost was so large that the usually gristly partition between the right and left halves of the nose-cavity became bony for a support, and this is always conspicuous in well-preserved skulls. The actual horns (which are never bony in rhinoceroses, but **Pier-cases 6–8. Table-case 4.**

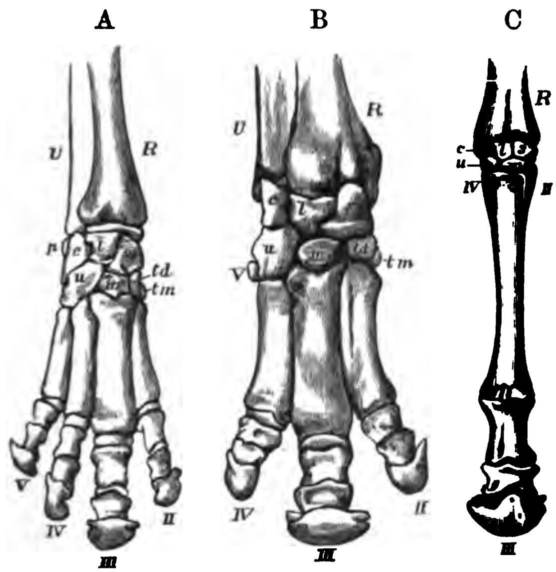

FIG. 9.—Skeleton of Fore foot of three existing Perissodactyl or Uneven-toed Ungulata—namely, Tapir (A), Rhinoceros (B), and Horse (C), much reduced in size. R, radius; U, ulna; *c*, cuneiform; *l*, lunar; *s*, scaphoid; *u*, unciform; *m*, magnum; *td*, trapezoid; *tm*, trapezium; II, III, IV, V, the several digits. (From Flower's "Osteology of the Mammalia.")

merely hardened clusters of hair) are only preserved in the frozen earth of the Arctic Circle. A small example is exhibited with some skulls in Pier-case 6. The bones and teeth of the woolly rhinoceros are common in British Pleistocene deposits and on the bed of the North Sea; and fine specimens are shown in Pier-case 6 and Table-case 4. Some fragmentary remains from Chartham in Kent, are especially interesting as being among the earliest discoveries of fossil bones in England to attract notice. They were

Pier-cases 6–8. Table-case 4.

described by William Somner in 1669 in a small printed tract entitled, "Chartham News; or, A Brief Relation of some strange Bones there lately digged up, in some grounds of Mr. John Somner of Canterbury;" but they were wrongly supposed to belong to some "sea-monster." One fine skull and associated bones were found in an excavation beneath the "Daily Chronicle" office in Fleet Street, London. Other fragmentary remains from English caverns prove that this rhinoceros was commonly preyed upon by the hyænas. One oval plate of bone from Kent's Cavern is particularly noteworthy, and exhibits deep tooth-marks round its edge. It

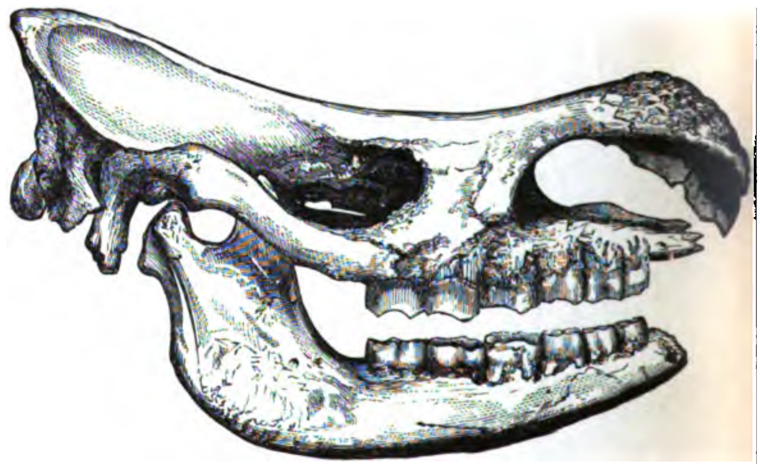

FIG. 10—Skull and lower jaw of the Slender-nosed Rhinoceros (*Rhinoceros leptorhinus*), from the Pleistocene of Ilford, Essex; one-eighth nat. size. (Brady Collection, Pier-case 6.)

is evidently the bone to which the front horn was fixed at the time when the hyænas gnawed it, and the limit of their gnawing was determined by the size of the base of this horn which has since decayed.

Pier-case 6. Table-case 4.

Two other species (*R. leptorhinus* and *R. megarhinus*) are represented in the Pleistocene deposits of England and the adjoining parts of the continent, in association with the woolly rhinoceros. Fine skulls of *R. leptorhinus* (Fig. 10) from the Thames Valley are placed in Pier-case 6; and there are teeth and jaws of this species and *R. megarhinus* both in Pier-case 6 and in Table-case 4. A slightly earlier rhinoceros (*R. etruscus*), which commonly occurs in the Upper Pliocene

of southern Europe, is also represented by jaws and teeth in the Norfolk Forest Bed, from which Mr. Savin collected the series of specimens in Pier-case 7. True two-horned rhinoceroses are found in the Lower Pliocene of Eppelsheim (Hesse-Darmstadt), Pikermi (Greece), the Isle of Samos, and Maragha (Persia), as shown by fine specimens in Pier-case 8. Pliocene rhinoceroses are likewise found in the Siwalik Formation of India, and here there are not only two-horned species but also direct ancestors of the one-horned species (*R. unicornis*) which now lives in India. Their remains were collected chiefly by Falconer and Cautley and are exhibited in Pier-case 7. **Pier-cases 7, 8.**

FIG. 11.—Skull and lower law of a Hornless Rhinoceros (*Aceratherium megalodus*), from the Upper Miocene of Colorado, U.S.A.; one-sixth nat. size. (After E. D. Cope.)

In the Miocene and Oligocene formations both of Europe and North America, and in the Lower Pliocene of Europe and Asia, there is evidence of numerous ancestral rhinoceroses, most of which were almost or quite hornless (e.g., *Aceratherium*). In fact, the American representatives of the Rhinoceridæ (Fig. 11) seem to have become extinct at the end of the Miocene period before they had acquired more than the slightest trace of a horn. As in the true modern rhinoceroses, of course, this structure is never fossilised—its presence or absence is merely inferred from the size of the nasal bones and from the presence or absence of a roughness **Pier-case 8.**

Pier-case 8. on the bone where the horn would be attached. The earliest rhinoceroses are the smallest and have the front teeth best developed. Some of them (*Hyracodon*), as proved by the shape of the back of the skull, could only use their jaws for crushing or chopping their food, and had not acquired the powerful grinding bite characteristic of their modern representatives. Illustrations are exhibited in Pier-case 8 and Table-case 4.

Pier-case 6. A very peculiar rhinoceros, *Elasmotherium sibiricum*, with a skull more than a yard in length, lived in Siberia and part of south European Russia in the Pleistocene period. It must have borne an enormous horn, not on the nose, but on a bony prominence in the middle of the forehead above the eyes. Its teeth, though formed on the rhinoceros-plan, are shaped like those of a horse. They have crimped enamel and must have been very effective grinders for a long-lived animal. Plaster casts of the skull and other remains are exhibited in Pier-case 6.

Pier-case 8. Case L. The **Titanotheriidæ**, of the Eocene and Oligocene periods in America, seem to have been closely related to the early rhinoceroses. Some typical remains of the latest genus, *Titanotherium* itself, are placed in Pier-case 8, and a fine skull is exhibited in a special Case (marked L). The head is shaped like that of a rhinoceros; but the roof of the nose-cavity bears a pair of small bony horns or horn-cores, and the teeth form an almost or quite continuous series in the mouth. The fore foot has four toes, of which the two middle ones are less unequal than in the tapirs; the hind foot has three toes. Some species attained a very large size, 15 to 18 feet in length (Fig. 12).

Pier-case 10. The typical one-toed horses (of family **Equidæ**), which are only found in a wild state at the present day in Africa and Asia, ranged also over Europe and the whole of North and South America during the Pleistocene period. Some of them, whose bones cannot be distinguished from those of *Equus caballus*, wandered even into the Arctic Regions. Most of them belonged to the genus *Equus*, but a few in South America were peculiar, notably the *Hippidium* and *Onohippidium* found in the Argentine Republic. As shown by a plaster cast of the skull in Pier-case 10, the latter genus was characterised by a remarkable development of the nose: it is also known to have possessed unusually short and stout legs. All the American horses seem to have become extinct before the New World was colonised from Europe in historic

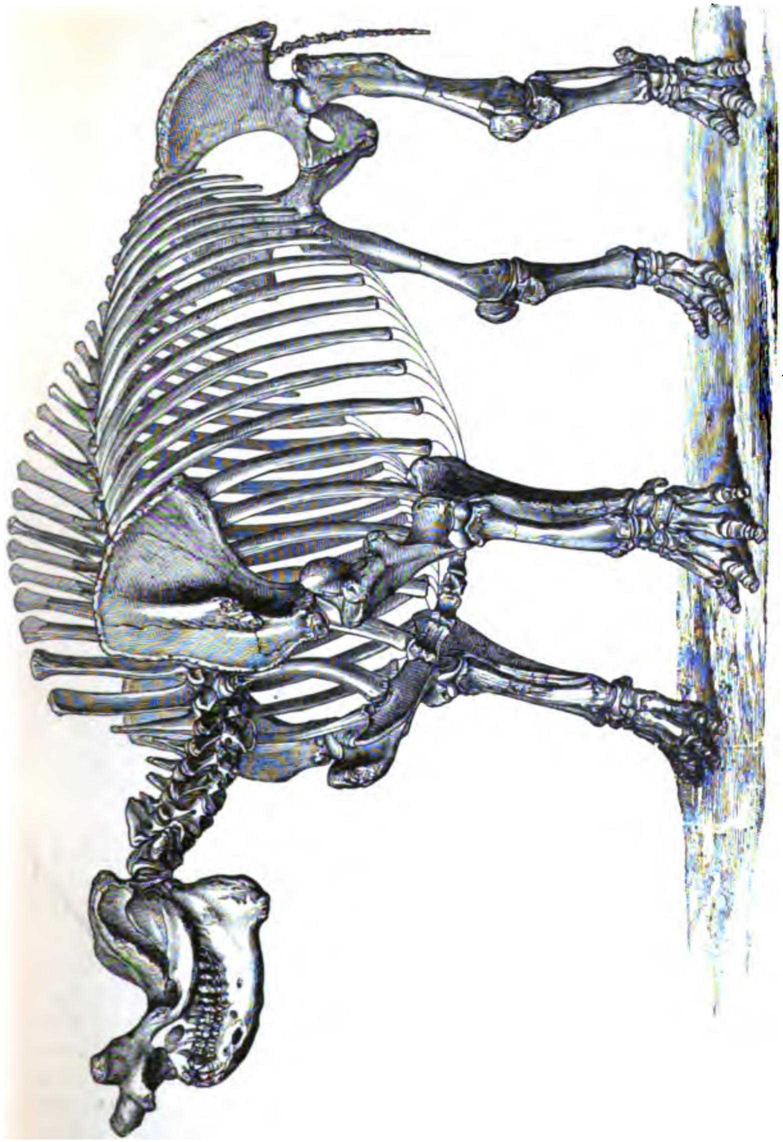

FIG. 12.—Skeleton of *Titanotherium (Brontops) robustum*, from the Oligocene of Dakota, U.S.A.; about one twenty-fourth nat. size. (After O. C. Marsh.)

times; and the so-called wild horses now found there are merely escapes from domestication.

Pier-case 10. Table-case 5. The earliest remains of one-toed horses hitherto discovered (Fig. 13, 1) occur in the Lower Pliocene Siwalik Formation of India (*Equus sivalensis*, Pier-case 10); and they are first found in Europe in the Upper Pliocene, in America in the Pleistocene. Their first appearance in England is in the Norfolk Forest Bed, and their remains are common both in the Pleistocene river-deposits of this country and in caverns (Pier-case 10). These true horses are immediately preceded in Asia, Northern Africa, Europe, and

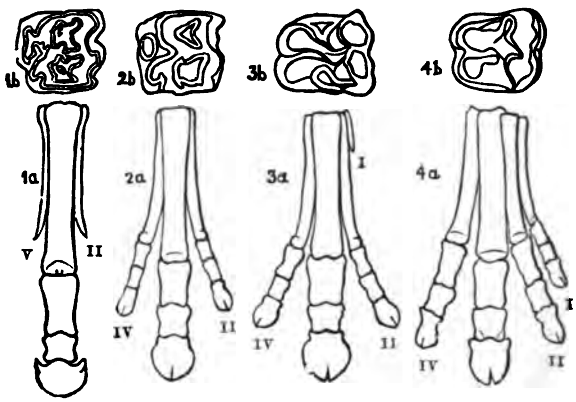

Fig. 13.—Diagram showing the gradual loss of toes in the fore foot (*a*) and increase of complexity in the grinding teeth (*b*) of successive Horse-like Ungulata from Europe—namely, *Hyracotherium* (4), *Anchitherium* (3), *Hipparion* (2), and *Equus* (1); much reduced, but not showing relative size. Digits numbered I, II, IV.

North America, by slightly smaller animals, which are already horses in every essential respect, but have a pair of complete though diminutive side toes on each foot. The Old World species belong to the genus *Hipparion* (Fig. 13, 2), and remains are exhibited from India, Persia, Samos, Greece, Italy, Germany, France, Spain, and the Red Crag of England. Complete legs, skulls, and other remains from Pikermi, Greece, are especially noteworthy in Pier-case 10. ***Hipparion*** has also been recorded from North America, where it immediately succeeds another three-toed horse, ***Protohippus***, which is not represented in the collection.

Table-case 5. The Miocene and Oligocene horse-like animals, both in Europe and in North America, are still smaller than the

Pliocene *Hipparion*. The grinding teeth in these animals **Table-case 5.** are less deepened than in the last-mentioned genus, those of the earlier forms being indeed quite low-crowned and only fit for comparatively succulent vegetation. The side-toes tend to become larger and touch the ground as they are traced back in geological time. Typical remains of *Anchitherium* (Fig. 13, 3), from the Middle Miocene of Europe, and of *Mesohippus*, from the Oligocene of North America, are exhibited in Table-case 5.

The Eocene horse-like animals are still smaller than the **Pier-case 9. Table-case 5.** later forms just mentioned, and their immediate connection with the horses would be difficult to recognise if all the links of Oligocene and Miocene age remained unknown. A plaster

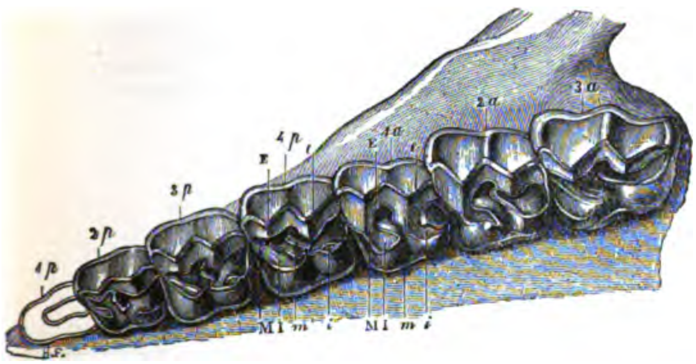

Fig. 14.—Left upper teeth in maxilla of *Palæotherium crassum*, from the Upper Eocene Gypsum of Montmartre, Paris; three-quarters nat. size. 1a–3a, three molars; 1p–4p, four premolars; other letters indicate various tooth-cusps. (After A. Gaudry.)

cast of *Protorohippus venticolus* from the Wind River Formation of Wyoming, U.S.A., exhibited in Pier-case 9, affords a good idea of one of these animals about as large as a fox, and there are actual remains of the closely related *Hyracotherium* (Fig. 13, 4) from the London Clay (Lower Eocene) of the London Basin in the same Case. The ridges on the grinding teeth are more or less subdivided into tubercles; the neck is not very mobile; the fore limb has a complete and separate ulna, allowing some power of twisting, and there are four spreading toes; the hind limb has only three complete toes. *Palæotherium* and *Lophiodon* are allied genera from the Eocene of Europe, and comprise some species as large as rhinoceroses. *Palæotherium* (Figs. 14, 15) was first

Pier-case 9. Table-case 5. discovered in the Paris Gypsum and studied by Cuvier, who rightly recognised many points of resemblance in it to the living tapirs, and published in 1825 the accompanying restored sketch of the animal (Fig. 15). As already mentioned, in fact, all the Eocene Perissodactyla are adapted for dwelling in marshes, like the tapirs; and they are preceded at the base of the Eocene by five-toed animals, like *Phenacodus* (Pier-case 9), which is one of the small-brained Condylarthra to be noticed below (p. 48).

The gradual changes in the feet, teeth, and skulls of the horse-like hoofed animals, as they are traced through the Tertiary period, are also illustrated by a series of plaster

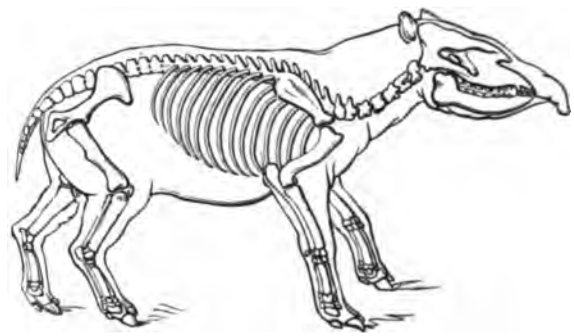

FIG. 15.—Restoration of the skeleton and outline of the body of *Palæotherium magnum*, from the Upper Eocene; about one-thirtieth nat. size. (After Cuvier.)

casts and models arranged in a Case in the Gallery of Domesticated Animals behind the Great Hall.

Pier-case 9. The distribution of the tapirs or **Tapiridæ** in the existing world is very curious, and has only been explained by the study of fossils. They occur exclusively in the Malayan region of Asia, and in the tropical parts of America, not in any intervening country. In the Pliocene and Miocene periods, however, they ranged over most of Asia, Europe, and North America. They are thus a vanishing race, which has survived only at the two extremities of its former area of distribution. A fine palate of *Tapirus priscus*, from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt, is exhibited in Pier-case 9. There are also isolated teeth of *Tapirus* from China and from the English Red Crag.

SUB-ORDER 2.—**Ancylopoda.**

During part of the Miocene and Pliocene periods in Europe, Asia and North America, there lived some large three-toed quadrupeds which had grinding teeth much like those of the Titanotheriidae and exhibited many resemblances to the Perissodactyla in general, but differed from all known Ungulata in the peculiar structure of the feet. In these animals the weight of the body when walking seems to have been mainly supported by the outer side of the twisted foot, while the phalanges of each digit curve upwards on highly-developed pulley-joints and end in a cleft, pointed, claw-shaped bone—an arrangement suggesting the name Ancylo- **Pier-case 9.**

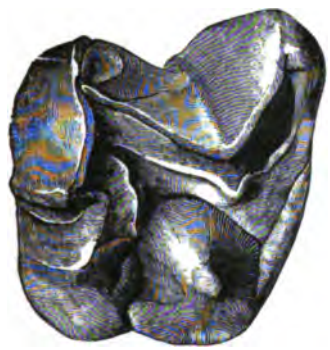

FIG. 16.—View of grinding surface of third right upper true molar tooth of *Chalicotherium sinense*, from the Pliocene of China; nat. size. (Pier-case 9.)

poda ("curve-feet") for the sub-order. The feet, indeed, are so much like those of the extinct ground-sloths of America and the existing pangolins (*Manis*) of the Old World, that the isolated toe-bones were referred to the Edentata until a nearly complete skeleton of one genus (*Macrotherium*) was found in the Miocene of France. Among the remains exhibited in Pier-case 9, may be particularly noted a toe of *Macrotherium* from the Middle Miocene of Sansan, France; a toe of *Ancylotherium* (lacking claw) from the Lower Pliocene of Pikermi, Greece; and teeth of *Chalicotherium* (Fig. 16) from the Pliocene of India and China.

SUB-ORDER 3.—**Artiodactyla.**

Pier-cases 11–19. Table-cases 6–10.

In another group of hoofed marsh-dwellers of the Eocene period the weight of the body soon became supported mainly by two of the middle toes (nos. III, IV), which grew to be of equal size. Hence the Artiodactyla or even-toed hoofed animals. In some cases, even before the close of the Eocene period, the side-toes had dwindled and practically disappeared, while the basal pieces (or meta-

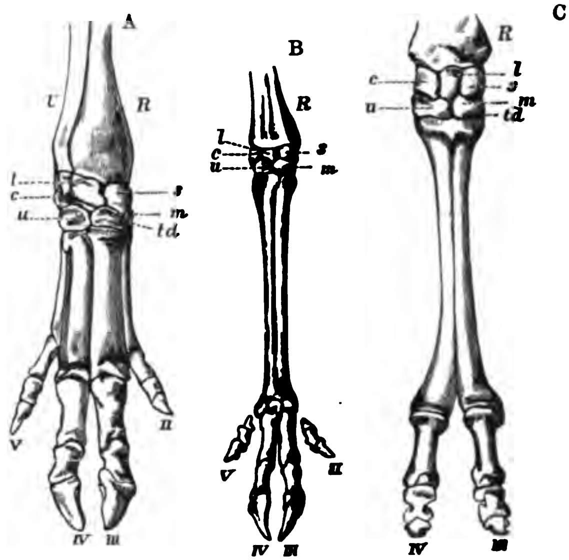

FIG. 17.—Skeleton of Fore foot of three existing Artiodactyl or Even-toed Ungulata—namely, Pig (A), Deer (B), and Camel (C), much reduced in size. R, radius; U, ulna; *c*, cuneiform; *l*, lunar; *s*, scaphoid; *u*, unciform; *m*, magnum; *td*, trapezoid; II, III, IV, V, the several digits. (From Flower's "Osteology of the Mammalia.")

podium) of the pair of supporting toes became fused together, thus producing the appearance of a "cloven hoof." As the successive Tertiary periods followed, the SUINA (pigs, peccaries, and hippopotamus) alone retained their four separate toes; the TYLOPODA (camels and llamas) gradually lost their side-toes, while the bases of their middle toes still remained imperfectly fused at their lower end; the TRAGULINA (chevrotains) and PECORA (giraffes, deer, sheep, and cattle) also lost their side toes more or less completely, and

the "cloven hoof" arrangement attained perfection, working on pulley-joints. These modifications of the feet are illustrated in Fig 17.

Pier-cases 11, 12. Table-case 6.

Except that they have a relatively large, highly-developed brain, and curiously modified front teeth which grow throughout life, the **Hippopotamidæ** are very little different from some of the early Eocene Artiodactyla. They have indeed completely retained the aquatic and marsh-dwelling habit. Although the hippopotamus is at present confined to Africa, it also ranged over a large part of Europe and Asia in the Pleistocene period. Remains of fine animals which cannot be distinguished by their bones and teeth from the existing African *Hippopotamus amphibius*, are not uncommon in England even so far north as Yorkshire. A large mandible and other remains from the valley of the Cam at Barrington, near Cambridge, are exhibited in Pier-case 11. In this and the adjacent Table-case 6, there are also teeth and bones of the same species from the Thames deposits, from Bedford, Essex, Oxfordshire, and Suffolk, and from the Norfolk Forest Bed. A mandible and other bones from the Upper Pliocene of Mont Perrier, Puy-de-Dôme, France, besides remains from the Arno valley in Italy, are likewise shown in Pier case 11. *H. pentlandi* is a smaller species, whose bones and teeth occur in such enormous accumulations in the caverns of Sicily, that they were dug out and exported from Palermo for many years to be calcined for use in sugar-refining. Remains of the same small species are shown from the caverns of Malta; and there is a still more pigmy animal, *H. minutus*, whose bones and teeth have lately been found in great abundance by Miss D. M. A. Bate in the caverns of Cyprus (see Table-case 6). The remains had probably been washed into the caverns by streams and floods. Another small species, *H. madagascariensis*, of which a reconstructed skeleton is exhibited in Pier-case 11, seems to have been quite common in Madagascar at a late geological period. No hippopotamus now lives in Madagascar, and the bones and teeth of this small species exhibit so many variations, that it doubtless had a severe struggle for existence. Although the hippopotamus is now extinct in India, several species lived there in the Pliocene and Pleistocene periods, as shown by the Cautley Collection in Pier-case 12 and Table-case 6 (Fig. 18). The Miocene and earlier representatives of the family still remain to be discovered, most likely in Africa.

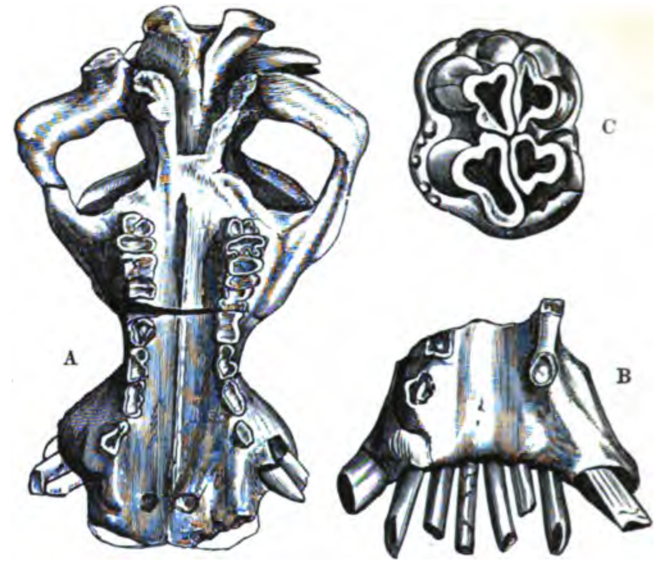

FIG. 18.—Palatal view of skull (A), symphysis of lower jaw (B), and grinding surface of molar tooth (C) of an extinct Hippopotamus (*Hippopotamus sivalensis*), from the Lower Pliocene of the Siwalik Hills, India; A and B one-eighth nat. size, C one-half nat. size. (Pier-case 12.)

Pier-case 13.

The true pigs, or **Suidæ**, have always been confined to the Old World, and the oldest known species is *Sus chœroides*, from the Middle and Upper Miocene of France and Italy. Among the fossil remains of this family in Pier-case 13 may be noticed skulls, jaws, and teeth of the wild boar from England and Ireland; some fine skulls and jaws of the large *Sus erymanthius*, from the Lower Pliocene of Pikermi, Greece; pieces of skulls and jaws of other extinct species from the Lower Pliocene of the Siwalik Hills, India; and similar remains of *Hippohyus sivalensis*, a pig from the Siwalik Formation with deepened grinding teeth rendered very effective by the crimping of their enamel.

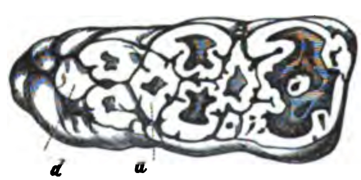

FIG. 19.—Grinding surface of third right lower true molar tooth of an existing Pig (*Sus cristatus*), from India; nat. size. *a*, *d*, middle columns of talon of tooth.

Nothing is known of the direct ancestors of the American peccaries (**Dicotylidæ**). Remains of the typical *Dicotyles* from the caverns of Brazil are exhibited in Table-case 7. **Table-case 7.**

Among earlier animals allied to the pigs, the large *Elotherium*, from the Oligocene and Miocene of Europe and North America, is especially remarkable. As shown by remains in Pier-case 13, it had only two toes, with the merest rudiment of the outer toes. *Listriodon*, from the Miocene of Europe and India, has a skull like a pig, but grinding teeth with cross-ridges like those of a tapir (Table-case 7). *Hyotherium* is provided with large upper canine teeth (Table-case 7). *Chæropotamus* is represented in the same Case by jaws and teeth from the Upper Eocene of the Isle of Wight and of France.

In these early allies of the pigs the molar teeth are nearly square and bear regularly arranged cusps or ridges. In some of them the tooth-cusps tend to become crescent-shaped, and hence make an approach to the trenchant crescentic ("selenodont") cusps of the teeth in the higher Artiodactyla which chew the cud ("ruminants"). One family, that of the **Anthracotheriidæ**, with molar teeth in this condition, arose in the Upper Eocene and was represented during the Oligocene period by many moderately large species, which ranged over the greater part of the northern hemisphere. These were stoutly-built animals, some probably much resembling the pigs in outward aspect, others more nearly allied to the hippopotamus. All of them have four or five separate toes. *Anthracotherium* ("coal beast") itself, which is well represented in Table-case 7, is so called from the circumstance that its remains were first discovered in the lignite or brown-coal of Savoy. It is chiefly found in the Oligocene of Europe, but also seems to occur in the corresponding deposits in Dakota, U.S.A., while a few teeth have been assigned to it from the Lower Pliocene Siwalik Formation of India. The European *A. magnum* must have been as large as a rhinoceros. *Hyopotamus* is another genus, of which the detached teeth (Fig. 20) are

FIG. 20.—Grinding surface of third right upper true molar tooth of *Hyopotamus bovinus*, from the Oligocene of Hempstead, Isle of Wight; nat. size. (Table-case 7.)

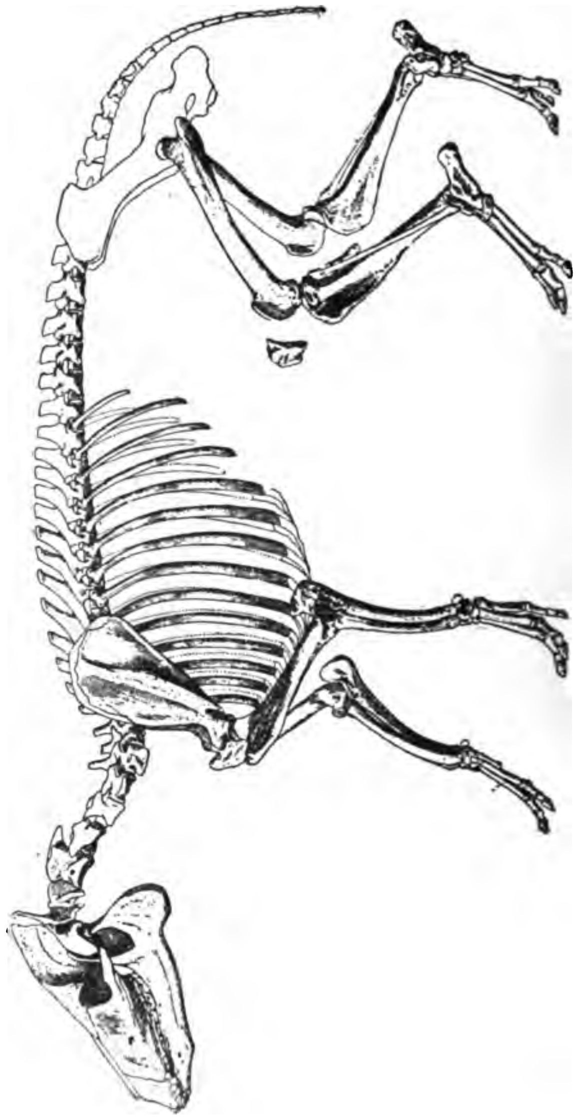

FIG. 21.—Skeleton of *Hyopotamus brachyrhynchus*, from the Oligocene of Dakota, U.S.A.; one-tenth nat. size. (After W. B. Scott.)

among the commonest fossils from the Hempstead Beds of the Isle of Wight (Table-case 7). Several skulls have been obtained from the Oligocene of Ronzon, France, and nearly complete skeletons from the Oligocene of Dakota, U.S.A. (Fig. 21). *Brachyodus* occurs not only in Europe, but also in the Miocene of Egypt. *Merycopotamus* is found in the Lower Pliocene Siwalik Formation of India and Burma, and various skulls and jaws are exhibited in Pier-case 13 and Table-case 7. **Table-case 7.**

The actual fore-runners of the ruminants are placed in Table-case 8. They show (1) the gradual acquisition of the typical "selenodont" molar teeth, (2) the beginning of the **Table-case 8.**

FIG. 22.—Right upper teeth of *Anoplotherium cayluxense*, from the Oligocene Phosphorites of France; nat. size. (Table-case 8.)

FIG. 23.—Right upper teeth of immature *Anoplotherium secundarium* from the Upper Eocene of Débruge, France; nat. size. (Table-case 8.)

gap ("diastema") between the front teeth and the back teeth, and (3) the gradual fusion of the bases of the two supporting toes. In the **Anoplotheriidæ**, which are well represented by *Anoplotherium* from the Upper Eocene of France, England, and Germany, the crescent-shaped tooth-cusps are low (Figs. 22, 23), the teeth are in a continuous row in the jaw without any gap, and there are three well-developed toes on each foot. The name *Anoplotherium* ("unarmed beast") was proposed by Cuvier, who first described the animal and was impressed by its complete lack of defensive weapons. The **Cænotheriidæ** are smaller four-toed animals, from the European Oligocene and Lower

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FIG. 24.—Skull of a primitive Ruminant (*Cænotherium filholi*), lateral (A), upper (B), and palatal (C) aspects, from the Oligocene Phosphorites of France; nat. size. (Table-case 8.)

Miocene formations, with deeper and more effective cusps on the molar teeth. As shown by the numerous skulls of *Cænotherium* in the collection (Fig. 24), there is often a slight gap between its canine tooth and the premolars. The **Xiphodontidæ** are small two-toed animals from the Upper Eocene and Oligocene of England, France, and adjoining countries. *Dichodon* (Fig. 26) is a typical genus. The **Oreodontidæ** are slightly more advanced ruminants ranging from the Upper Eocene to the Upper Miocene in North America. Fine skulls of *Oreodon* are exhibited, showing the lower canine tooth shaped like an incisor, while the foremost premolar is enlarged to usurp its function. **Table-case 8.**

The nearest surviving relatives of these primitive ruminants are the little chevrotains, or **Tragulidæ**, which are now found only in the marshes of the Indo-Malayan region and western Africa. They never possess horns, but

FIG. 25.—Side-view of skull and mandible of existing Chevrotain (*Tragulus javanicus*), from the Malayan region; reduced in size.

they agree with the giraffes, deer, and antelopes in having lost their upper front teeth (Fig. 25). Fossil remains of the family are exhibited in Table-case 8. *Prodremotherium*, from the Oligocene of France, is essentially similar to the living *Tragulus*, with the enlarged upper canine teeth. *Dorcatherium*, of which a fine skull is shown from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt, is apparently identical with the living *Hyæmoschus*.

Of the true ruminants the **Tylopoda**, or camels and llamas, seem to have originated in North America, where they can be traced back by fossils from the Pliocene and Miocene formations to a little gazelle-shaped creature of the Oligocene period, *Poebrotherium*. This small animal, of which a skull and limbs are exhibited in Pier-case 13, has a more nearly complete set of teeth than the modern camels, and the basal bones in its feet are not entirely fused together. **Pier-case 13.**

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Pier-case 13. There were no camels later than the Pliocene period in North America. About that time, however, the represen-

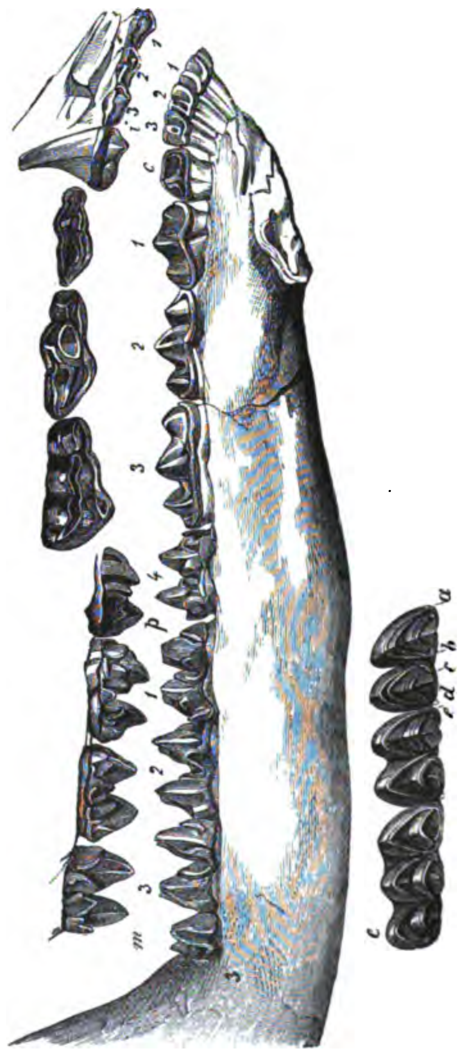


FIG. 26.—Teeth, premaxilla, and left mandibular ramus of a primitive Ruminant (*Dichodon cuspidatus*), from the Upper Eocene of Hordwell, Hampshire; nat. size. *i* 1–3, incisors; *c*, canine; *p* 1–4, premolars; *m* 1–3, molars. Upper premolars 1–3 are shown from the grinding surface, and lower molars 1–3 are shown from the same aspect below the jaw. (Table-case 8.)

tatives of the llamas wandered over the newly emerged Isthmus of Panama to South America, where they have since flourished; while the true camels by some means

reached Asia, as proved by numerous remains from the Siwalik Formation of India in Pier-case 14. **Pier-case 14.**

The giraffes, or **Giraffidæ**, have always been Old World quadrupeds. Though now confined to Africa, they also ranged over the greater part of Asia and southern Europe in the Lower Pliocene period, as shown by fossils from China, India, and Greece in Pier-case 14. Even the long-limbed and long-necked *Giraffa* itself was in existence at that time, but it seems to have been less common than the antelope-shaped relatives of the okapi, which has only escaped extinction by retreating to the recesses of the Semliki forest. *Samotherium*, with a pair of horns only in the male (Fig. 27), is known by **Case M. Stand N.**

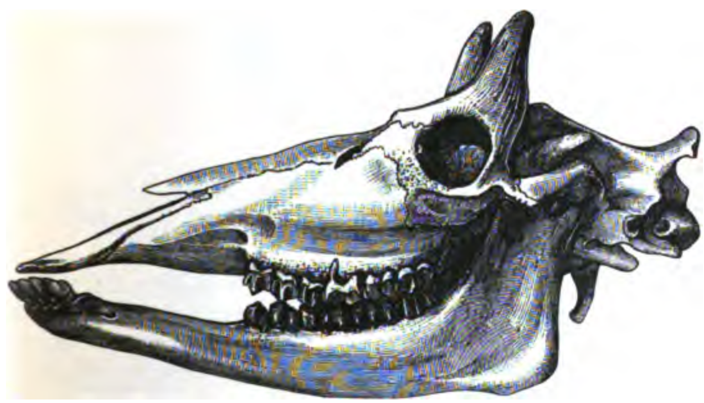


FIG. 27.—Skull and lower jaw of an extinct Okapi (*Samotherium boissieri*), from the Lower Pliocene of the Isle of Samos; one-sixth nat. size. (Case M.)

many remains from the Lower Pliocene of Pikermi (Greece), the Isle of Samos, and Maragha (Persia), and it is scarcely distinguishable from the okapi. The original skull of this animal, described by Dr. Forsyth Major, is exhibited in a special Case marked M. *Helladotherium* is a larger and stouter relative, of which the female at least is hornless, represented by numerous fragments from Pikermi. *Sivatherium*, from the Siwalik Formation of India, is equally stout, and the male bears two pairs of horns, one simple pair being on the frontal bones, a large expanded pair further back (Fig. 28). The actual skull, detached horn-cores, limb-bones, and other remains of this animal are exhibited in Pier-case 14, while a restored model of the head is mounted on a separate pedestal (N). *Hydaspitherium* and *Bramatherium*

Pier-case 14. Stand N.

are contemporary genera from the Siwalik Formation of India.

FIG. 28.—Front view of skull of an extinct Giraffe-like animal (*Sivatherium giganteum*), from the Lower Pliocene of the Siwalik Hills, India; one-thirteenth nat. size. (Stand N.)

Pier-case 15. Table-cases 9, 10. Stands Q, R.

The deer, or **Cervidæ**, were as widely distributed in the Pleistocene period as at the present day, and some of the European species at that time possessed the largest known antlers. The great Irish deer, *Cervus giganteus,* is especially remarkable in this respect, the antlers of the male often measuring slightly more than nine feet across and exhibiting a considerable expansion. This animal (Fig. 29) is sometimes termed an elk, but the shape of the nose and the presence of a brow-tyne on each antler show that it is a true deer. The male alone bears antlers, and reconstructed skeletons of both sexes from Irish peat-bogs are mounted on stands Q, R, in the middle of the Gallery. Several skulls and antlers, to show their variability, are placed on the top of the Pier-cases, and there are also skulls with jaws in Pier-case 15. The remains are especially common in the marl at the bottom of the Irish peat-bogs, where the animals seem to have perished when the present bogs were either swamps or lakes; and there is evidence that they were not all exterminated in Ireland until comparatively late prehistoric times. During recent years several specimens have been dug up in the Isle of Man, and these probably date back to the time before the Irish Sea was formed. During the Pleistocene period numerous

varieties of the species seem to have ranged over the greater part of Europe. Jaws from the English caverns and river-deposits are exhibited in Table-case 10, and there is a male skull (lacking antlers) of the Italian race, *Cervus euryceros*, from Lombardy, in Pier-case 15. A skull with incomplete

Pier-case 15. Table-cases 9, 10. Stands Q, R.

Fig. 29.—Skeleton of male Irish Deer (*Cervus giganteus*), from shell marl beneath a peat bog, Ireland; about one-thirtieth nat. size. (Stand Q.)

antlers from Russia is mounted on the top of Pier-case 11. The Pleistocene representatives of the common stag or red deer, *Cervus elaphus*, in western Europe were sometimes of gigantic size, as shown by fragments of antlers from Kent's Cavern in Table-case 10. Moderately large antlers from river-deposits and lake-deposits in the British Isles are

Pier-case 15. Stands Q, R. mounted in Pier-case 15 and on blocks fixed to various pillars in the Gallery (Fig. 30). A specially fine pair of

FIG. 30.—Antler of Red Deer (*Cervus elaphus*), one of a pair dredged from the River Boyne at Drogheda, Ireland; one-tenth nat. size. (Pillar between Pier-cases 16, 17.)

FIG. 31.—Skull and antlers of Reindeer (*Rangifer tarandus*), from Bilney Moor, East Dereham, Norfolk. (After Owen.)

antlers from a deposit of tufa near Bakewell, Derbyshire, is placed in a case on the top of Pier-case 16. There are also associated remains of an extinct fallow deer (*C. browni*) in Pier-case 15, and of the roebuck (*Capreolus caprea*) in Table-case 10. The reindeer (*Rangifer tarandus*) during the Pleistocene period wandered as far south as the Pyrenees and Alps, and there are fine antlers (Fig. 31) from **Pier-case 15. Table-case 10.**

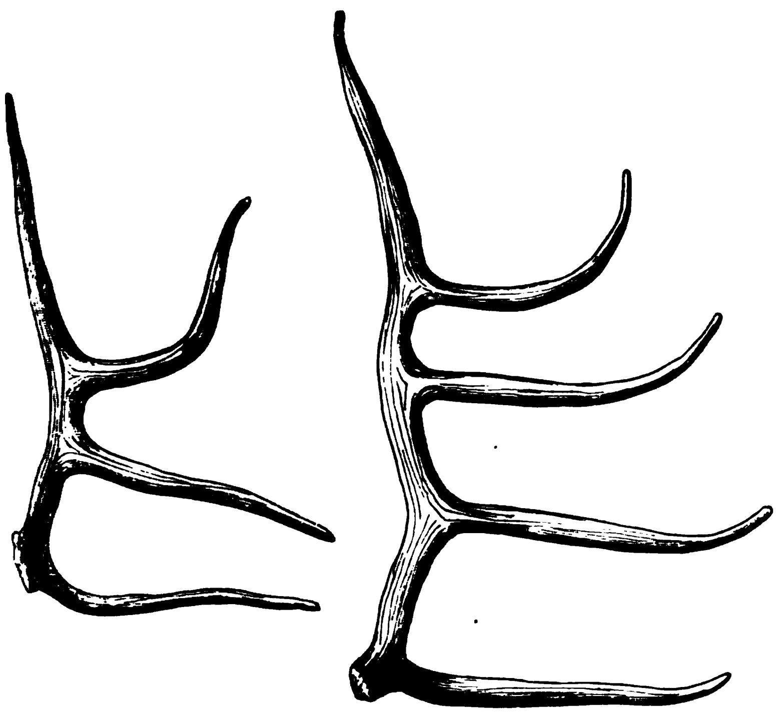


FIG. 32.—Antlers of fifth and sixth years of "*Cervus*" *tetraceros*), from the Upper Pliocene of Peyrolles, France; one-tenth nat. size. (Pier-case 15.)

the Thames valley and other English localities in Pier-case 15. This animal is said to have survived in Caithness so late as the twelfth century, but experiments have shown that even when imported and allowed suitable feeding ground it is unable to exist in that country now. The elk (*Alces machlis*) also lived in Pleistocene Britain as far south as the Thames valley (see Pier-case 15 and the pillar between **Pier-case 15.**

Pier-case 15.

Pier-cases 12, 13). A large extinct species, *Alces latifrons*, flourished here at the beginning of the Pleistocene period, its remains occurring with those of several extinct kinds of deer in the Norfolk Forest Bed. The Savin Collection of antlers of deer and elk from this deposit, near Cromer, is exhibited in Pier-case 15.

Antlers of deer related to *Cervus* occur first in the Upper Pliocene of Europe, and among them may be noted those of the so-called *Cervus tetraceros* from France (Fig. 32). A series of antlers of this animal, representing individuals of different ages, is mounted in the upper part of Pier-case 15. It will be noticed that the number of tynes on the antlers increases with age, as in the common stag (Fig. 33, C, D) and in all

FIG. 33.—Antlers of various Deer, much reduced in size. A. *Cervulus dicranoceros*; Lower Pliocene. B. *Cervus pardinensis*; Upper Pliocene. C, D. *Cervus elaphus*, second year and adult; Pleistocene and Recent. E. Bony pedicle and antler of existing Muntjak, *Cervulus muntjac*. F. Existing Fallow Deer, *Cervus dama*.

other deer with elaborate antlers; but the complexity and size of the Upper Pliocene antlers never equal those of some of the Pleistocene antlers. The Lower Pliocene and Upper and Middle Miocene deer-antlers are still smaller and simpler, as shown by examples in Table-case 9 (see also Fig. 33, A). The Lower Miocene deer, as represented by *Amphitragulus* from France and Germany, are small and quite destitute of antlers, like the living musk-deer (*Moschus*) of Asia. The geological history of the antlers in the race of deer thus

Table-case 9.

corresponds exactly with the life-history of the antlers in any individual modern deer—at first there are no antlers, then single prongs, then increasing complexity until the maximum is reached in full maturity. **Table-case 9.**

The antelopes, sheep and oxen, or **Bovidæ**, attain their greatest development at the present day. They are essentially an Old World family, and do not appear to have reached America until the close of the Pliocene period. The present distribution of many species, however, is quite limited, compared with their range in the Pleistocene period. The Saiga antelope (*Saiga tatarica*), now living on the Siberian steppes, then wandered as far west as England; and a frontlet from the Thames deposits at Twickenham is exhibited in Pier-case 16. The European bison (*Bison bonasus*), now surviving in Lithuania and the Caucasus, ranged throughout the greater part of Europe and even to the Arctic regions. Fine frontlets from England and various Arctic localities are arranged in Pier-case 16. The American bison and allied species flourished in the New World. The Musk-ox (*Ovibos moschatus*), now confined to the extreme north, came south with the reindeer as far as the Pyrenees; and there are typical remains from the Thames Valley in Pier-case 16. The urus (*Bos primigenius*), which was seen by Cæsar in historic times in the Hercynian forest, was quite common in the **Pier-cases 16–19.** **Pier-case 16.**

FIG. 34.—Skull of the Urus (*Bos primigenius*), from the British Pleistocene; one-fourteenth nat. size. (Pier-case 18.)

Pleistocene period throughout Europe (Fig. 34). Sir Antonio Brady's collection of the remains of this ox from Ilford,

Pier-case 18. Essex, is placed with other British specimens in Pier-case 18. The animal seems to have become extinct in the British Isles long before the dawn of history, and it was succeeded by the imported Celtic short-horn (*Bos longifrons*), of which **Pier-case 19.** numerous remains are shown in Pier-case 19. The latter species is supposed to be the ancestor of the existing small Welsh and Scottish cattle.

Skulls of primitive cattle collected chiefly by Colonel Sir Proby T. Cautley in the Lower Pliocene of the Siwalik **Pier-case 17.** Hills, India, are exhibited in Pier-case 17. The females of some species seem to have been hornless. Skulls of *Bubalus* from the Pleistocene of the Narbada Valley, India, are also placed in Pier-case 19. The horn-cores of one specimen have a span of over six feet.

Goats and sheep are almost unknown among fossils, but **Pier-case 16.** a few fragments are shown in Pier-case 16.

Skulls and other remains of extinct antelopes, chiefly from the Lower Pliocene of Greece, the Isle of Samos, Persia, and India, are arranged in Pier-case 16. *Palæoreas*, *Tragoceros*, and *Criotherium* are especially noteworthy. Among the remains of gazelles, there is a horn-core (*Gazella anglica*) from the Lower Pliocene Coralline Crag of Suffolk.

SUB-ORDER 4.—**Amblypoda.**

Pier-case 20. From some of the preceding observations it is evident that most of the existing mammals can be traced back by a series of gradations to small five-toed creatures, with an insignificant brain-capacity, at the beginning of the Eocene period. A few of the herbivorous mammals of the primitive grade never advanced beyond this lowly condition, but grew to unwieldy proportions, like those of a rhinoceros or elephant. Their head became large, but the brain itself always remained ridiculously small (Fig. 35A). Their limbs became massive pillars, with little five-toed stumpy feet (Fig. 35B, C), merely to support the overgrown body. They are appropriately named Amblypoda (" blunt feet ") in allusion to the latter feature. They lived only during the Eocene period, but they seem to have been very widely distributed, their remains having been found in Europe, Egypt, North America, and perhaps South America.

Pier-case 20. The first described fragment of an Amblypod is a piece of mandible named *Coryphodon eocænus* by Owen in 1846, probably from the London Clay, but dredged off the Essex

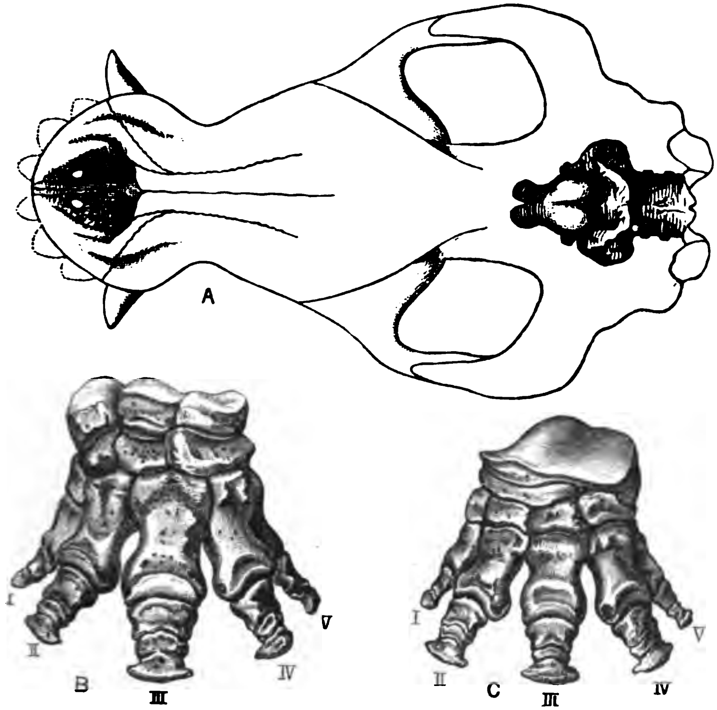


FIG. 35.—Outline of upper view of skull (A) to show size of brain, with fore (B) and hind (C) feet, of an Amblypod (*Coryphodon hamatus*), from the Lower Eocene of Wyoming, U.S.A.; A one-fifth, the others one-third nat. size. (After O. C. Marsh.)

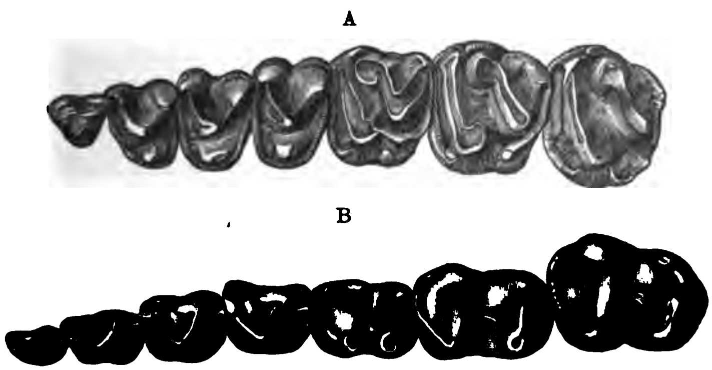


FIG. 36.—Left upper (A) and lower (B) grinding teeth of *Coryphodon hamatus*, from the Lower Eocene of Wyoming, U.S.A.; one-half nat. size. (After O. C. Marsh.)

Pier-case 20. coast near Harwich. It is exhibited in Pier-case 20. Other remains of *Coryphodon* are known from the Lower Eocene of England and France, and nearly complete skeletons have been found in rocks of the same age in North America. The grinding teeth (Fig. 36) are adapted for succulent food, and

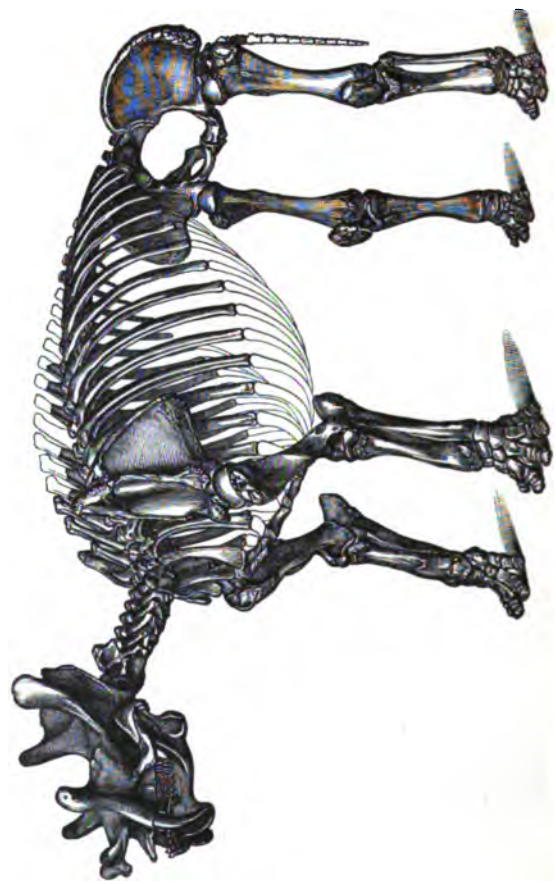


Fig. 37.—Skeleton of an Amblypod (*Tinoceras ingens*), from the Middle Eocene of Wyoming, U.S.A.; one-thirtieth nat. size. (After O. C. Marsh. See Case U.)

the canine teeth are only slightly enlarged. All the species are hornless, and some seem to have attained a body-length of about six feet.

The Middle Eocene Amblypoda, hitherto discovered only in North America, are curiously horned, and commonly known as Dinocerata (terrible-horns). A papier maché copy of a complete skeleton of *Dinoceras* (or *Uintatherium*)

mirabile from the Bridger Formation of Wyoming, presented by Professor O. C. Marsh, is mounted in a special Case marked U. A plaster cast of a skull of *Tinoceras ingens* (Fig. 37) is placed beneath it; and a series of brain-casts to show the relatively small size of its brain is arranged in front. The skull bears three pairs of bony prominences, which increase in size backwards, and seem to have been covered merely with skin. These bony horns and the brain-case are almost solid, with very few cavities. The upper canine teeth are much enlarged, and are protected by long flanges depending from the mandible. **Pier-case 20. Case U.**

FIG. 38.—Skull and lower jaw of *Arsinoitherium zitteli*, from the Upper Eocene of the Fayum, Egypt; one-twelfth nat. size. (Case S.)

Arsinoitherium and its allies from the Upper Eocene of the Fayum, Egypt, are technically Amblypoda, but their precise affinities are still uncertain. A unique skull and mandible (Fig. 38) is mounted in a special Case marked S, **Pier-case 22. Case S.**

Pier-case 20. Case U. and numerous remains are arranged in Pier-case 22. The brain is somewhat better developed than in the Dinocerata, and the teeth are deepened for the effective grinding of dry vegetation, while the canine teeth are quite small and crowded between the continuous regular series of premolars and incisors. There is one pair of small bony horn-cores above the eye, and there is an immense pair of horn-cores in front, which seem to be the excessively enlarged nasal bones. These horn-cores, like the rest of the large skull, are formed by a mere hollow shell of bone, and the grooves for blood-vessels in their surface suggest that they were originally covered with a sheath of true horn.

SUB-ORDER 5.—**Hyracoidea.**

Pier-case 20. The small existing hyraxes of Africa, Arabia, and Syria, are the scarcely altered survivors of a group of Eocene hoofed mammals allied to the Amblypoda and Condylarthra. They seem to have originated in the African region, and jaws of one hyracoid (*Megalohyrax eocænus*), as large as a donkey, are shown from the Upper Eocene of the Fayum, Egypt (Pier-case 20). *Pliohyrax*, from the Lower Pliocene of Pikermi (Greece), the Isle of Samos, and Maragha (Persia), must have been equally large. Several fossil hoofed animals found in the Tertiary rocks of South America have been doubtfully associated with this sub-order.

SUB-ORDER 6.—**Condylarthra.**

Pier-case 20. These are the small primitive five-toed hoofed animals of the Eocene period, which might serve very well for the ancestors of all later Ungulata. They occur both in Europe and North America, but the most satisfactory specimens have been found in the latter country. *Phenacodus* (Figs. 39, 40), of which a plaster cast of a nearly complete skeleton is exhibited in Pier-case 9, is a typical example. Fragments of jaws of Condylarthra are also shown in Pier-case 20.

SUB-ORDERS 7–9.—**Typotheria, Toxodontia,** and **Litopterna.**

Pier-cases 20, 21. Table-case 11. South America seems to have been separated from the rest of the world during the greater part of the Tertiary period, and its indigenous hoofed mammals, commonly

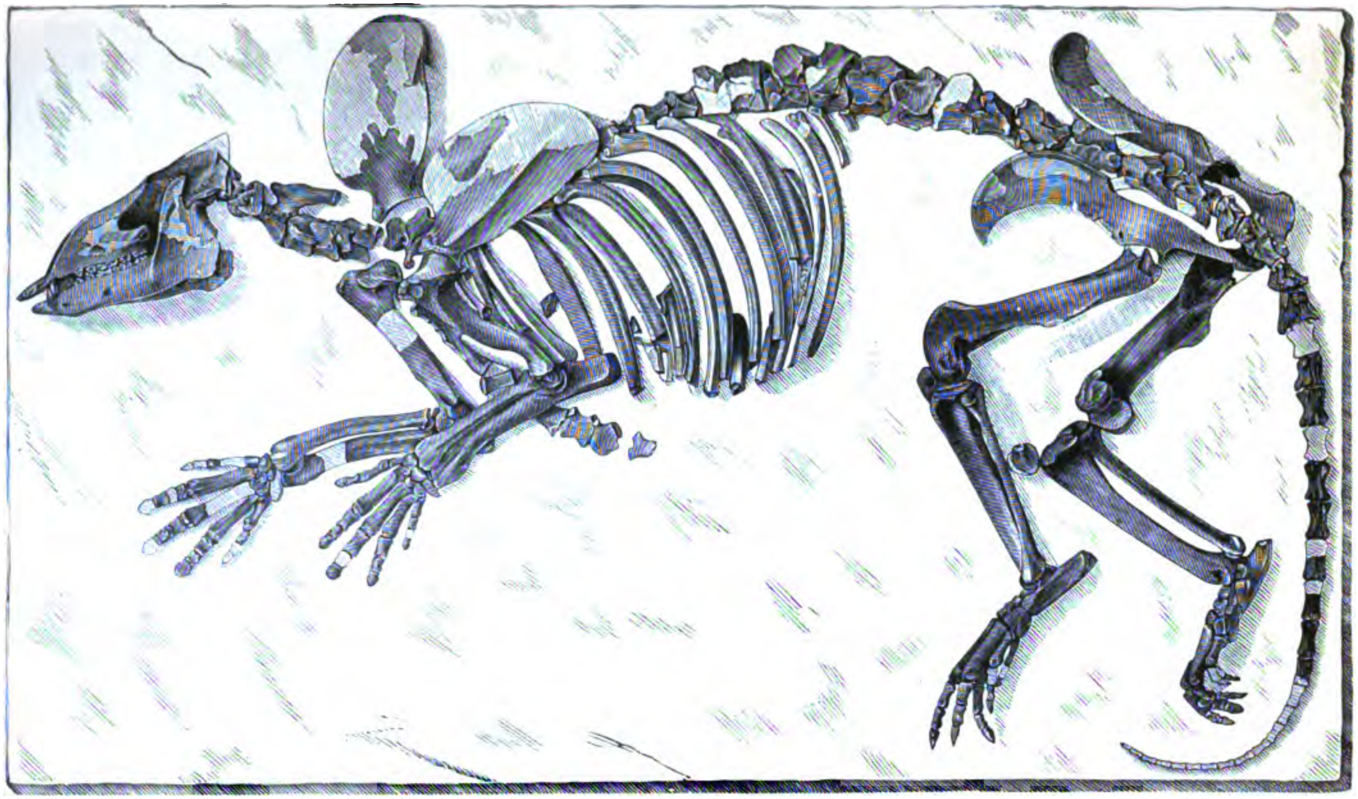


FIG. 39.—Skeleton of a primitive hoofed Mammal (*Phenacodus primævus*), from the Lower Eocene of Wyoming, U.S.A.; about one-seventh nat. size. (Pier-case 9.)

Pier-cases 20, 21. Table-case 11. arranged in three sub-orders, are nearly all different from any found elsewhere. The South American llamas, deer, peccaries, tapirs, extinct horses and mastodons, of course, are not indigenous, but passed south over the newly emerged isthmus of Panama or other land-bridge at the beginning of the Pliocene period.

Some of the earliest known South American hoofed mammals, such as *Pyrotherium*, are very little different from the Amblypoda and Condylarthra of the northern hemisphere. Plaster casts of jaws, teeth, and feet of *Pyrotherium* from **Pier-case 20.** Patagonia are exhibited in Pier-case 20. The later forms, however, are peculiar in the folding and complication of their often persistently-growing teeth; also in the structure

FIG. 40.—Skeleton of *Phenacodus primævus*, as now mounted in the American Museum of Natural History, New York.

Pier-case 20. Case T. of their feet when they begin to become plain-dwellers and mimic the rhinoceroses and horses of the rest of the world. *Toxodon* (Fig. 41) is an especially remarkable beast with ever-growing powerful cutting and grinding teeth, well seen in actual specimens in Pier-case 20. A plaster cast of a reconstructed skeleton of this large animal from the Pampa of the Argentine Republic, now in the La Plata Museum, is mounted in a special Case marked T. When alive it must have been shaped much like the contemporaneous rodents and giant armadillos. It was preceded in time by *Nesodon* and other smaller kinds of which remains are shown in Table-case 11. *Macrauchenia*, also from the Pampa Formation, was a large animal shaped liked a llama, but with three

separate toes on each foot. In this hoofed quadruped the lower end of the ulna and fibula has not disappeared, as is **Pier-case 20. Case T.**

Fig. 41.—Skeleton of *Toxodon platensis*, from the Pampa Formation of Buenos Aires, Argentine Republic; one-eighteenth nat. size. (Case T.)

Table-case 11.

the case in all Ungulata with similar feet living in the northern hemisphere. Some of the small **Proterotheriidæ**, which are found in the Santa Cruz Formation (perhaps Miocene) of Patagonia, have the toes reduced to one on each foot, exactly as in the horses; but here again the ulna and fibula are complete. They are named Litopterna ("smooth-heel") because the calcaneum is provided with a smooth facette for articulation with the end of the fibula. In outward appearance they must have been much like pigmy horses.

SUB-ORDER 10.—**Proboscidea.**

Wall-cases 28, 43. Pier-cases 29-42. Table-cases 17-24.

The elephants at the present day are found only in Africa and the Indian region, but during the Pleistocene period they ranged over nearly the whole of the northern hemisphere, roaming even within the Arctic circle. The mammoth (*Elephas primigenius*), which was almost identical with the living Indian elephant, had the widest distribution, its remains being especially abundant in the frozen Arctic lands and occurring almost everywhere in the north temperate region. There were local variations of the species; and among other features it may be noticed that the grinding teeth from the north exhibit finer and closer triturating plates than do those from the south, both in the Old World and in America, where the extreme southern forms are known as *E. armeniacus* and *E. columbi* or *texanus* respectively. No mammoths, however, were larger than the modern Indian elephant, and they can only be said to have commonly exceeded this living species in the development of their stout curly tusks, of which several fine examples (one from Eschscholtz Bay measuring 12 ft. 6 in. along the curve) are shown in Pier-case 29 (30) and on the top of this and adjacent Pier-cases. These tusks are so common and so well preserved in some parts of the Arctic regions, that they are a valuable source of ivory and have long been collected as an article of commerce. The mammoth is, indeed, best known from discoveries within the Arctic circle, where not only the fresh bones and teeth but also whole carcases are occasionally met with in the frozen earth. One such carcase was made known to science a century ago by Adams, who found it at the mouth of the Lena and brought the greater part of the skeleton, with the head and feet still covered by the skin and soft parts, to St. Petersburg in 1806. Photographs of this skeleton, as it is now mounted with some

Pier-case 29 (30).

restoration in the Imperial Academy of Sciences at St. Petersburg, are placed on the wall adjoining Pier-case 30 (see also Fig. 42). Another carcase of a small, young male, exposed by a landslip on the banks of the Beresowka, an affluent of **Pier-cases 29, 31.**

FIG. 42.—Skeleton of Mammoth (*Elephas primigenius*), with remains of dried skin on head and feet, discovered in frozen earth near the mouth of the river Lena, Siberia, and now in the Zoological Museum of the Imperial Academy of Sciences, St. Petersburg.

the Kolyma, in the government of Jakutsk, was scientifically excavated by an expedition from the St. Petersburg Academy in 1902; and photographs of the specimen, taken by Dr. Herz during the progress of its disinterment, are placed with

Pier-cases 29, 31. explanatory sketches on the pillar between Pier-cases 31 and 32. This animal evidently fell into a hole when quietly browsing on grass; its sprawling attitude shows that it attempted to scramble out; a great amount of clotted blood found in the chest-cavity indicates that it burst a blood-vessel by over-exertion; and a mouthful of grass between the teeth, not yet swallowed, proves that death was quite sudden. This specimen has been skilfully preserved in the Imperial Academy of Sciences at St. Petersburg, the skin being partially restored and stuffed in the attitude of the death-struggle, the skeleton mounted separately, and the other soft parts placed in bottles. **Pier-case 31.** As proved by this and other discoveries, the Arctic mammoth was well clothed in reddish-brown wool and long black hair, while the tail was tipped by a large tassel of hair. A piece of the woolly skin and a bottle filled with the long hair are exhibited with the collection of remarkably fresh bones of the mammoth from the Arctic regions in Pier-case 31. Jaws, teeth and bones from the Thames valley, including Sir Antonio Brady's remarkable collection from Ilford, are arranged in Pier-case 32 **Pier-case 32. Case K.** and the adjacent Table-case 17; while the finest skull of a mammoth (with complete tusks 10 ft. 6 in. in length) hitherto discovered in Britain, is mounted in a special Case marked K in the middle of the Gallery. This specimen was also found in a brickfield at Ilford, and seems to have been associated with a whole skeleton, which was unfortunately dug out in pieces and sold by the workmen to a local rag and bone merchant before the interest of the discovery was recognised. In the English collection there is evidence of mammoths of all ages, and an instructive series of teeth **Table-cases 17, 17a.** of young individuals is placed in Table-case 17A. The specimens of greatest geological antiquity are the molars in Table-case 17 obtained by Mr. A. C. Savin from the Norfolk Forest Bed. Molars from numerous localities in England and on the Continent are arranged in Table-case 18 to illustrate distribution and variation; and a series dredged from the bed of the North Sea (chiefly the Owles Collection) **Table-cases 18, 19.** is placed in Table-case 19 (Figs. 43, 44). Molars of the southern race from the Old World and North America, named *Elephas armeniacus* and *E. columbi*, are exhibited in Table-case 17.

The Pleistocene allies of the existing African elephant had a less extensive geographical distribution than the mammoth, and they never ranged sufficiently far north to

pass into the New World. The best known species is *Elephas antiquus*, with narrow molar teeth (Fig. 45) and straight tusks, which has not been found farther north than **Table-cases 18, 19.**

FIG. 43.—Grinding surface of left last upper molar tooth of Mammoth (*Elephas primigenius*), dredged off the Dogger Bank, North Sea, one quarter nat. size. (Table-case 19.)

FIG. 44.—Mandible of Mammoth (*Elephas primigenius*), dredged off the Dogger Bank, North Sea; one-sixth nat. size. (Pier-case 32.)

the Kirkdale Cave in the Vale of Pickering, Yorkshire. The teeth are less common in Europe than those of the mammoth, but a good English collection is exhibited in Pier-case 33, and the series includes a characteristic straight tusk. The **Pier-case 33.**

Pier-case 33.

most ancient specimens were obtained from the Norfolk Forest Bed and from the Pliocene Norwich Crag. Molars of young individuals, chiefly found in England, are arranged in Table-case 19A. Teeth intermediate between those of *E. antiquus* and *E. africanus* occur in northern Africa, and there are remains of dwarf races in the caverns of Malta, Sicily, and Cyprus. The pigmy elephants of Malta (*E. melitensis* and *E. mnaidriensis*) and Cyprus (*E. cypriotes*) are especially interesting, and must have varied from three to seven feet in height when full-grown. A large collection of their remains is exhibited in Table-cases 21, 21A, those from Malta having been collected by Admiral Spratt and Professor Leith Adams, those from Cyprus by Miss D. M. A. Bate. There are also a few jaws and teeth of the Sicilian forms in Table-case 21. It is commonly supposed that these animals were stranded on the islands where the remains are found,

Table-cases 19a, 21, 21a.

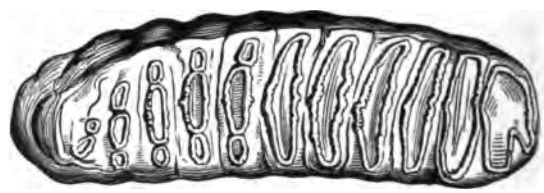


FIG. 45.—Grinding surface of right second lower molar tooth of *Elephas antiquus*, from the Pleistocene of Grays, Essex; one-third nat. size. (Pier-case 33.)

when the Mediterranean assumed its present extent in the Pleistocene period and disintegrated the once continuous mainland. Their small size and innumerable variations are thus ascribed to the struggle for existence on a reduced and unfavourable feeding ground.

The largest known elephant, apparently allied to the surviving African species, lived during the Upper Pliocene period to the dawn of the Pleistocene in the southern half of Europe. It was first discovered in the valley of the Arno, Italy, and named *Elephas meridionalis*. A nearly complete skeleton from Durfort, Gard, France, now mounted in the Paris Museum, shows that the animal must sometimes have measured 14 or 15 feet in height. Molar teeth (Fig. 46) and other remains occur in the Norfolk Forest Bed, and a good collection is exhibited with some Italian specimens in Table-case 20. A few pieces are also shown from the Pliocene Red

Table-case 20.

Crag and Norwich Crag, and there is one molar from a fissure in the Chalk at Dewlish, Dorset. Photographs of the circumstances under which the latter specimen was discovered are fixed on the wall in the bay between Pier-cases 34, 35. **Table-case 20.**

Remains of true elephants are quite common in the Lower Pliocene Siwalik Formation and in the Pleistocene river-deposits of India. All of these are closely related to the living Indian elephant, but some, such as *E. planifrons* and *E. hysudricus*, seem to be intermediate between the surviving Indian and African species. The Cautley Collection and numerous other specimens in Pier-cases 33 and 34, Table-case 22, and on special stands, form a unique illustration of these extinct members of the Indian fauna. **Pier-cases 33, 34. Table-case 22. Stands O, P, W.**

FIG. 46.—Grinding surface of upper molar tooth of *Elephas meridionalis*, from the Upper Pliocene of Tuscany; one-third nat. size. (Table-case 20.)

The Indian species just mentioned are the earliest known examples of the true elephant, which thus makes its first appearance in the Lower Pliocene of Asia. With the typical kinds are associated other elephants which possess more primitive grinding teeth, and show how the elephantine molar originated. They prove, in fact, that this ponderous tooth has gradually arisen in the elephant tribe by the enlargement and complication of a tooth with a few cross-ridges. The first stage (among elephants with a normal proboscis or trunk) is found in *Mastodon* (" nipple-tooth "), which is represented by *M. sivalensis* (Fig. 50) and other species in the Siwalik Formation (see Pier-cases 36, 37, and Table-case 23). A longitudinal vertical section of this kind of tooth (Fig. 47) displays the thick cross-ridges separated by wide valleys, which are quite empty or only partially blocked by small supplementary knobs or ridges. The next stage, named *Stegodon* (" roof-tooth ") in allusion to the **Pier-cases 36, 37. Table-case 23.**

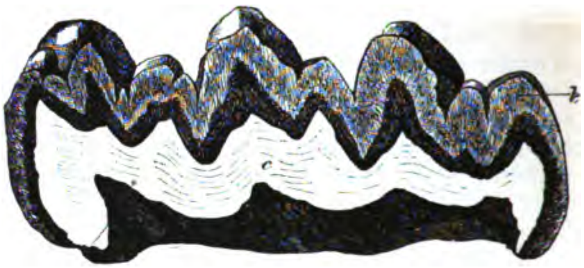


FIG. 47.—Vertical longitudinal section of molar tooth of ***Mastodon***, showing open valleys between cross-ridges, thick enamel (*b*), and the dentine (*c*); two-thirds nat. size. (Table-case 24.)

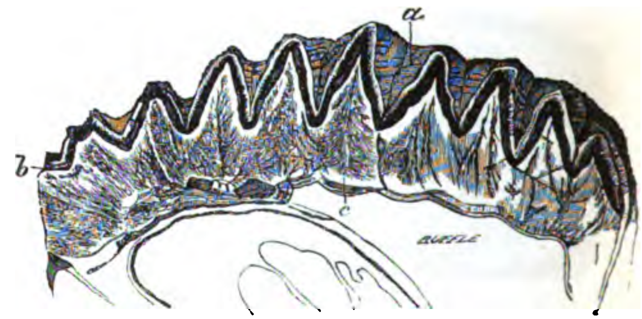


FIG. 48.—Vertical longitudinal section of molar tooth of ***Elephas*** **(*Stegodon*)** ***insignis***, from the Lower Pliocene of the Siwalik Hills, India, showing wide valleys between cross-ridges filled with cement (*a*), the layer of enamel (*b*), and the dentine (*c*); one-third nat. size. (Table-case 24.)

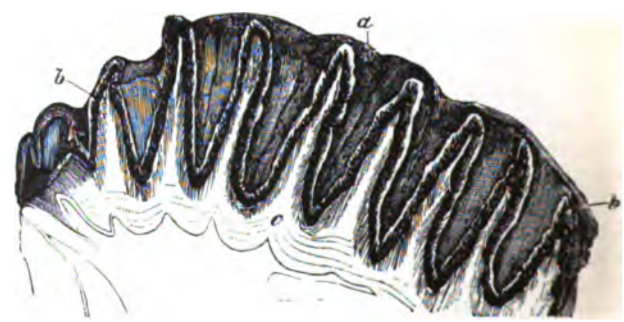


FIG. 49.—Vertical longitudinal section of molar tooth of ***Elephas planifrons***, from the Lower Pliocene of the Siwalik Hills, India, showing deep valleys between cross-ridges filled with cement (*a*), the layer of enamel (*b*), and the dentine (*c*); one-third nat. size. (Table-case 24.)

FIG. 50.—Grinding surface of lower molar tooth of *Mastodon sivalensis* from the Lower Pliocene of the Siwalik Hills, India; two-thirds nat. size. (Table-case 23.)

FIG. 51.—Grinding surface of upper molar tooth of *Elephas* (*Stegodon*) *clifti*, from the Lower Pliocene of the Siwalik Hills, India; one-half nat. size. Pier-case 36.)

FIG. 52.—Grinding surface of incomplete upper molar tooth of *Elephas planifrons*, from the Lower Pliocene of the Siwalik Hills, India; two-thirds nat. size. (Pier-case 34.)

Pier-cases 36, 37. Table-case 23.

angular roof-like shape of the cross-ridges of the teeth (Figs. 48, 51), has these ridges more numerous and usually deeper, while the intervening valleys are partly filled with a soft tooth-substance termed cement. *Stegodon* is generally regarded as a sub-genus or section of *Elephas* proper, and various remains of it from India, Burma, and China are exhibited in Pier-cases 35, 36. A fine skull of *Elephas* (*Stegodon*) *ganesa* with immense tusks (Fig. 59) from the Siwalik Formation, presented by General Sir W. E. Baker, is mounted on a separate stand (J). In the true *Elephas* the tooth-ridges are excessively deepened and comparatively numerous (Figs. 49, 52), while the intervening valleys, now mere crevices, are filled to overflowing with cement. This progressive complication is well illustrated by a series of sections of teeth arranged in regular order in Table-case 24.

Pier-cases 35, 36. Stand J.

Table-case 24.

The Pliocene *Stegodon* has only been found in southern and central Asia, some of the adjacent islands, and northern Africa. *Mastodon*, however, ranged over southern and central Europe, and in the Pleistocene period extended nearly throughout North and South America. Among European species may be mentioned *M. arvernensis*, from the Upper Pliocene of France, Italy, Germany, and the Red Crag of England, illustrated in Pier-case 37 and Table-case 23; also *M. atticus* and *M. pentelici* from the Lower Pliocene of Greece, exhibited in the same Cases. Among North American species *M. americanus* (Figs. 53, 54) is the most important, and is represented not only by the partially reconstructed skeleton (Stand B) at the entrance to the Gallery, but also by numerous remains in Pier-case 38 and Table-case 23. It lived until the arrival of prehistoric man in North America, as shown by the occurrence of stone arrow-heads with its bones. The best known South American species is *M. humboldti*, of which a fine skull is mounted in Pier-case 39 (40). Though found nearly all over South America, its remains are especially abundant in the lake deposits or flood deposits in the valley of Tarija, Bolivia, where large herds must have perished.

Pier-case 37. Table-case 23.

Pier-case 38. Table-cases 23, 24. Stand B.

FIG. 53.—Lower molar tooth of *Mastodon americanus*, from the Pleistocene of North America; one-third nat. size. (Table-case 23.)

The Pliocene and Pleistocene mastodons just enumerated clearly possessed the ordinary elephant proboscis, and would be elephants to all outward appearance. Young individuals, however, exhibit a diminutive pair of tusks projecting from the front of the lower jaw. They are thus reminiscent of their predecessors of the Miocene period in Europe and northern Africa, which had well-developed and functional lower tusks throughout life. These ancestral mastodons, of the genus *Tetrabelodon*, are illustrated by numerous remains from the Middle and Upper Miocene and Lower Pliocene of **Pier-cases 38–42. Table-cases 23, 24. Stand B.**

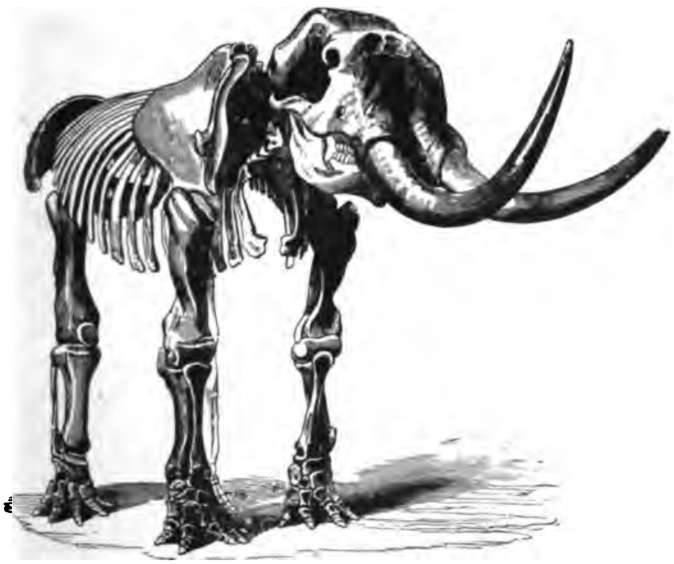


FIG. 54.—Skeleton of *Mastodon americanus*, from the Pleistocene of Benton County, Missouri, U.S.A.; greatly reduced. (Stand B.)

Europe in Pier-case 41 (42). None of the species were so large as those of the genus *Mastodon* itself. Their skull (Fig. 60) is quite like that of an elephant, and the spreading upper tusks only differ from modern elephant tusks in being provided with a band of enamel along one side. Their lower jaw, however, is produced at the chin (symphysis) into a remarkable bony spout-shaped elongation, tipped with a pair of chisel-shaped tusks, which cannot have worked against the upper tusks, but evidently met some kind of pad on the palate. *Tetrabelodon* must thus have possessed an immensely **Pier-case 41.**

Pier-case 41.

elongated face, and as its neck was longer than that of a modern elephant, it would be able to reach the ground with the front of its mouth. The general shape of the animal is well shown by a partially restored skeleton in the Paris Museum, of which a photograph is placed on the wall near Pier-case 41 (see also Fig. 55).

FIG. 55.—Skeleton of *Tetrabelodon angustidens*, from the Middle Miocene of Sansan, France; greatly reduced. (After A. Gaudry.)

FIG. 56.—Left upper milk-molars of *Tetrabelodon longirostris*, from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt; nat. size. (After A. Gaudry.)

Wall-case 43. Case C.

Dinotherium, a contemporary of *Tetrabelodon*, with smaller, simpler and more numerous grinding teeth, has the bony symphysis of its mandible bent downwards and the terminal lower tusks curved backwards. The only known skull of this animal, with a plaster cast of the mandible (Fig. 57) from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt, is mounted in a special Case marked C; and teeth (Fig. 58)

and other remains both from Europe and the Siwalik Formation of India, are exhibited in Table-case 23 and Wall-case 43. **Wall-case 43. Case C.**

Fig. 57.—Skull and mandible of *Dinotherium giganteum*, from the Lower Pliocene of Eppelsheim, Hesse-Darmstadt; one-fifteenth nat. size. (Case C.)

Fig. 58.—Left upper teeth of *Dinotherium giganteum*, from the Middle Miocene of Sansan, France; one-quarter nat. size. (After A. Gaudry.)

No Proboscidean earlier than *Tetrabelodon* occurs in Europe; but it is preceded in the Upper Eocene of Egypt by **Wall-case 43.**

Wall-case 43. a still smaller animal, *Palæomastodon*, of which various remains are exhibited in Wall-case 43. This genus (Fig. 61)

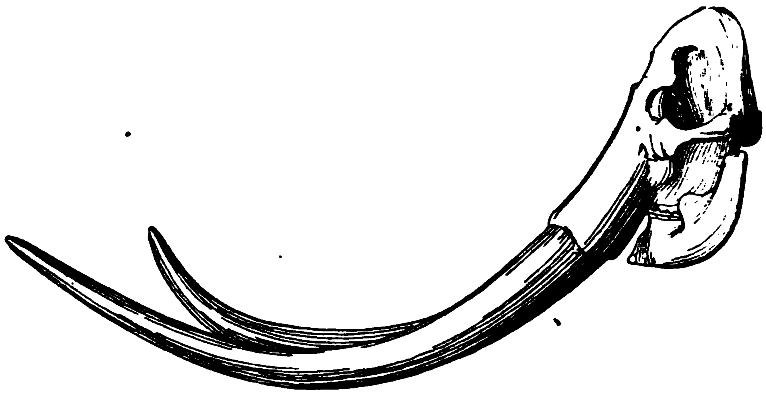


FIG. 59.—Skull and lower jaw of *Elephas* (*Stegodon*) *ganesa*. showing immense tusks, from the Lower Pliocene of the Siwalik Hills, India; one thirty-second nat. size. (Stand J.)

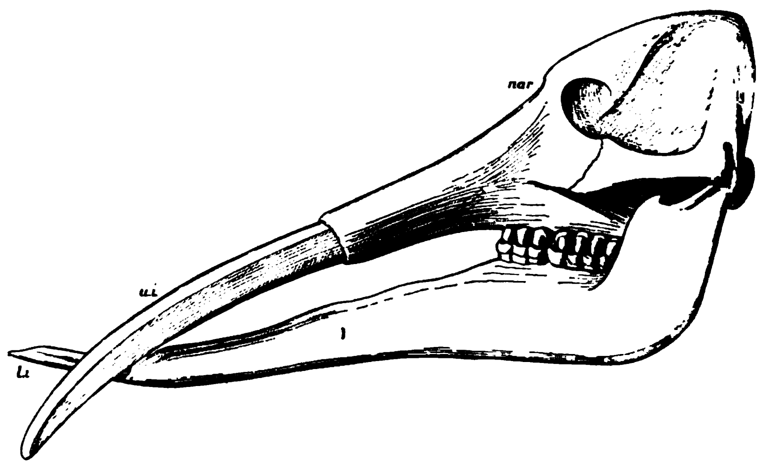


FIG. 60.—Skull and lower jaw of *Tetrabelodon angustidens*, showing elongated chin with pair of terminal cutting teeth (*l.i.*), from the Middle Miocene of Sansan, France; one-twentieth nat. size. *nar.* position of nostrils; *u.i.* upper incisor or tusk. (After C. W. Andrews.)

resembles *Tetrabelodon* in its tusks and elongated face, but differs in having a less elephant-like skull, with more numerous and relatively smaller grinding teeth. It is

preceded again in the Middle Eocene of Egypt by *Moeritherium* (Fig. 62), which comprises still smaller species whose relation to *Elephas* would hardly be suspected if all the intermediate gradations were unknown. Here the cross- **Wall-case 43.**

Fig. 61.—Skull and lower jaw of *Palæomastodon beadnelli*, showing elongated chin with pair of terminal cutting teeth (*l.i.*), from the Upper Eocene of the Fayum, Egypt; one-twelfth nat. size. *nar.* position of nostrils; *u.i.* upper incisor or tusk. (After C. W. Andrews.)

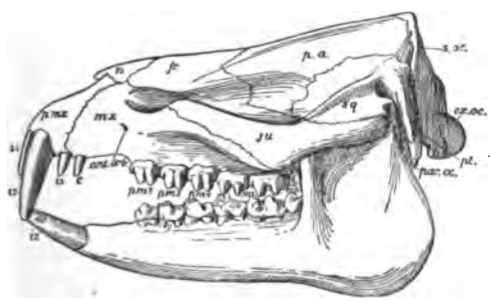


Fig. 62.—Skull and lower jaw of *Moeritherium lyonsi*, from the Middle Eocene of the Fayum, Egypt; one-seventh nat. size. *ant orb.*, antorbital foramen; *c.*, canine; *ex. oc.*, exoccipital; *fr.*, frontal; *i.* 1-3, incisors; *ju.*, jugal; *m.* 1-3, molars; *mx.*, maxilla; *n.*, nasal; *p.a.*, parietal; *par. oc.*, paroccipital; *p.m.* 2-4, premolars; *p. mx.*, premaxilla; *pt.*, post-tympanic process of squamosal; *s.oc.*, supraoccipital: *sq.*, squamosal. (After C. W. Andrews.)

ridged molars are first becoming recognisable; one pair of incisors above and below is growing at the expense of its fellows to become real tusks; and the arrangement of the bones of the skull is beginning to show features which are known only in the order Proboscidea. Several instructive

Wall-case 43.

fragments, and plaster casts of skulls from the Cairo Museum, are placed in Pier-case 43.

The fossils, so far as known, show therefore that the earliest forerunners of the elephants were small marsh-dwellers which lived on a succulent food in the African region. They gradually increased in size, without essentially altering their limbs and body; but as their legs lengthened and their neck shortened, their face and chin gradually became elongated to reach the ground for browsing. When this strange adaptation had reached its maximum degree, the chin suddenly shrivelled, leaving the flexible, toothless face without any support. Thus arose the unique proboscis of the elephants, which has become prehensile by stages which cannot be traced, because soft parts are not preserved in ordinary geological formations.

For comparison, a stuffed modern Indian elephant, and a skeleton of the same are placed in the middle of the Gallery (stands D, E); while the head of an African elephant, skulls and tusks are arranged in the bay between Pier-cases 36 and 37. Recent skulls and teeth, some described by Corse in the "Philosophical Transactions of the Royal Society" more than a century ago, are also placed in Pier-case 28.

ORDER VI.—**RODENTIA.**

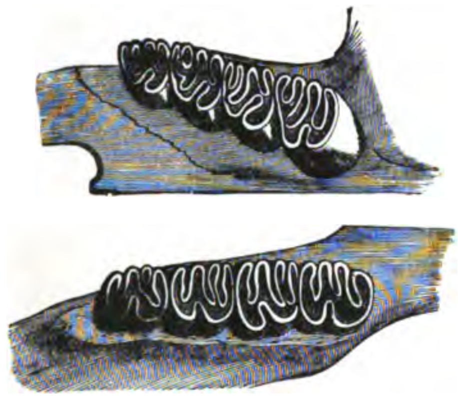
Table-case 16.

Fossil remains of rodents or gnawing mammals are common in Tertiary formations throughout the world, and a typical collection is exhibited in Table-case 16. The extinct kinds, however, do not differ much from those now living, although they can be traced back as far as the Middle Eocene period.

Among the fossil remains of Sciuromorpha, those of the beaver (*Castor*) are conspicuous. This animal first appears in the Upper Pliocene of Italy, France, and England; and the common *C. fiber* had a remarkably wide range in Europe during the Pleistocene period. Good specimens are shown from the Fen-land (Fig. 63) and from the valley of the Lea, Essex. It does not appear to have been exterminated in Britain until about the twelfth century, and there are still allusions to it in some names of places (e.g., Beverley and Nant-yr-afancwm). *Trogontherium cuvieri* is a giant beaver, which ranged from Russia to England during early Pleistocene times. A skull, jaws, and other remains from the Norfolk Forest Bed are exhibited, with plaster casts of a Russian skull and mandible of the same species.

Among Myomorpha, it is interesting to notice that the lemmings (*Myodes lemmus* and *Cuniculus torquatus*) occur in the Pleistocene of England. There are also remains of a large dormouse (*Leithia melitensis*) found with the pigmy elephants in the caverns of Malta. **Table-case 16.**

A



B

FIG. 63.—**Left upper (A) and right lower (B) teeth of Beaver (*Castor fiber*), from the Fens of Cambridgeshire; nat. size.**

Among Hystricomorpha, a skull of the gigantic *Castoroides ohioticus* from the Pleistocene of North America is shown; and there is a drawing of a complete skeleton of this animal, natural size, on the adjacent wall. There are also remains of various genera from South America, where the extinct Pleistocene *Megamys* (not represented in the collection) must have been as large as an ox.

The Lagomorpha, or rabbits, picas, and hares, date back to the Oligocene period.

ORDER VII.—SIRENIA.

The extinct representatives of the "sea-cows," so far as known, are very little different from the surviving members of the Order. Recent discoveries in Egypt merely suggest that during the Eocene period they were most closely connected with the early Proboscidean Ungulata. Various fossils show that in Tertiary times they had a wider geographical distribution than at the present day. **Pier-case 29 (30). Case V.**

Steller's Sea-cow (*Rhytina gigas*), which formerly browsed on the sea-weed on the shores of Bering Strait, lived until 1782, when it was exterminated by the Russian sailors who

Pier-case 29 (30). Case V.

fed upon its flesh. It was described by Steller, a German naturalist in the Russian service in 1751, and a copy of his drawing of the living animal is fixed on the Pillar between Pier-cases 20 and 21. This massive creature sometimes attained a length of 25 feet; and a nearly complete skeleton of an individual about 20 feet long (Fig. 64) is mounted, with other remains, in a large case marked V. *Rhytina* was destitute of teeth, which were replaced by corrugated, horny plates; it also appears to have lacked ordinary hands. Its bones occur in the peat-bogs and swamps of the islands round which it lived, and they are discovered by prodding the soft ground with an iron bar which strikes them.

FIG. 64.—Skeleton of Steller's Sea-cow (*Rhytina gigas*), from Pleistocene of Bering Island; one-fortieth nat. size. (Case V.)

Halitherium from the Oligocene and Lower Miocene of Europe, is essentially a manatee, but it lacks the apparently unlimited supply of grinding teeth which characterise the surviving animal. It also exhibits a less rudimentary pelvis than any other known Sirenian, with a small bone representing the femur. A restored model of a skeleton of *Halitherium schinzi* about 8 feet long (Fig. 65) from the Oligocene of Hesse-Darmstadt, is mounted in Case V; and there are numerous actual remains of this species from the same locality in the collection. There is also an imperfect skull, named *Halitherium canhami*, from the Red Crag of Suffolk (see Table-case 1A.). *Felsinotherium* is a closely similar animal from Northern Italy.

Pier-case 29 (30).

Prorastomus is another extinct genus known only with certainty by the unique skull from an early

Tertiary limestone in Jamaica, which is exhibited in Pier-case 29 (30). It is peculiar in possessing a complete set of teeth, incisors and canines as well as premolars and molars. Fragments of jaws, possibly of another species of the same genus, occur in the Upper Eocene of Northern Italy. **Pier-case 29 (30).**

FIG. 65.—Skeleton of *Halitherium schinzi*, from the Oligocene of Hesse-Darmstadt; one twenty-fifth nat. size. (Case V.)

The oldest known Sirenians are *Eotherium* and *Eosiren* from the Middle Eocene of Egypt. Brain-casts, a plaster cast of a skull, and other remains are exhibited in Pier-case 29 (30).

Skeletons and stuffed specimens of the living manatees and dugongs are placed in Case V and Pier-case 29 (30) for comparison with the fossils. See "Guide to the Galleries of Mammals," p. 84.

ORDER VIII.—CETACEA.

The fossil remains of whales, porpoises, and dolphins are placed with the living members of the Order in the Gallery of Cetacea (Department of Zoology). They are all very fragmentary. **Gallery of Cetacea, Zool. Dept.**

The typical modern Balænidæ do not occur below the Pliocene, where they are represented chiefly by ear-bones (tympanics), of which a good series from the Red Crag of Suffolk is exhibited (Fig. 66). Small whalebone whales, however, existed so long ago as the Oligocene period both in Europe and North America, although there are no remains in the collection.

Teeth and bones of the toothed whales are more frequently met with among fossils. All the kinds which still live seem to have been in existence before the close of the Pliocene period. Even the strange compact snouts of the beaked whales, such as *Mesoplodon*, are common fossils in the Pliocene Crag of England and Belgium, and a good collection is mounted for exhibition. Some of the earlier

Gallery of Cetacea, Zool. Dept.

toothed whales of the Miocene period differed from every Cetacean now living, and approached more normal mammals in the circumstance, that all their teeth were enamelled, while some of those at the back of the jaw were two-rooted. Instructive illustrations may be seen in plaster casts of skulls of *Squalodon grateloupi* from the Miocene of France and

FIG. 66.—Tympanic bone of Whalebone-whale (*Balæna primigenia*), from the Red Crag of Suffolk; one-half nat. size.

FIG. 67.—Skull (A) and upper molar tooth (B) of *Zeuglodon cetoides*, from the Eocene of Alabama, U.S.A.; A greatly reduced, B one-fifth nat. size.

Bavaria, and in an almost unique skull of *Prosqualodon australis* from the Patagonian Formation of South America.

The Miocene toothed-whales with enamelled two-rooted teeth are especially interesting, because they connect the modern simple-toothed tribes with some whale-like creatures, the Zeuglodonts, which appear to have flourished in the seas

throughout the world during the Eocene period. *Zeuglodon* (yoke-tooth), thus named by Owen in allusion to the shape of its hinder teeth (Fig. 67B), has jaws so peculiar that they were originally supposed to belong to a reptile, which was termed *Basilosaurus*. The skull (Fig. 67A) is not completely that of a whale, though it is elongated and depressed, with the nostril on the middle of the upper surface. Each side of either jaw is provided with four simple teeth in front and five double-rooted teeth behind. The neck must have been unusually long for a whale and not rigid. There are also traces of an armour of small bony plates. Plaster casts of the skull and teeth, besides actual teeth of the typical *Zeuglodon cetoides*, from the Eocene of Alabama, U.S.A., are exhibited, proving the animal to have been of rather large size. A plaster cast of part of a skull of *Z. osiris* from Egypt is also shown. **Gallery of Cetacea, Zool. Dept.**

ORDER IX.—EDENTATA.

The sloths, anteaters, and armadillos have been characteristic of the South American region since early Tertiary times, and they do not appear to have wandered farther than the southern part of North America at any period. They are quite a degenerate and insignificant race at the present day, compared with their former representatives.

The modern sloths and anteaters are almost unknown among fossils, but the peculiarities of both these families are combined in the skeleton of the extinct **ground-sloths.** These animals, in fact, exhibit the head and teeth of a sloth associated with the back-bone, limbs, and tail of an anteater. They lived in great numbers in South America during the latter part of the Tertiary period, ranging even so far north as Kentucky in the Pleistocene; and some of them survived to be contemporaries of man at a very recent Prehistoric date. The Miocene or perhaps Upper Eocene forms are quite small, but they become larger as they are traced upwards in the geological sequence, and many of the Pleistocene and Prehistoric species rival elephants and rhinoceroses in bulk. **Wall-case 26. Table-cases 14b, 15a. Case Y.**

The best known ground-sloths are *Megatherium*, *Scelidotherium*, and *Mylodon*, all well represented in the collection. They obviously could not live in trees like the little sloths which exist at present in the South American forests; but their hind quarters are very massive and their stout tail would serve with their hind legs to form a rigid tripod on

Stand X. Case Y. which they could rest when reaching the leaves of trees for food. A plaster cast of the skeleton of ***Megatherium***, 18 feet

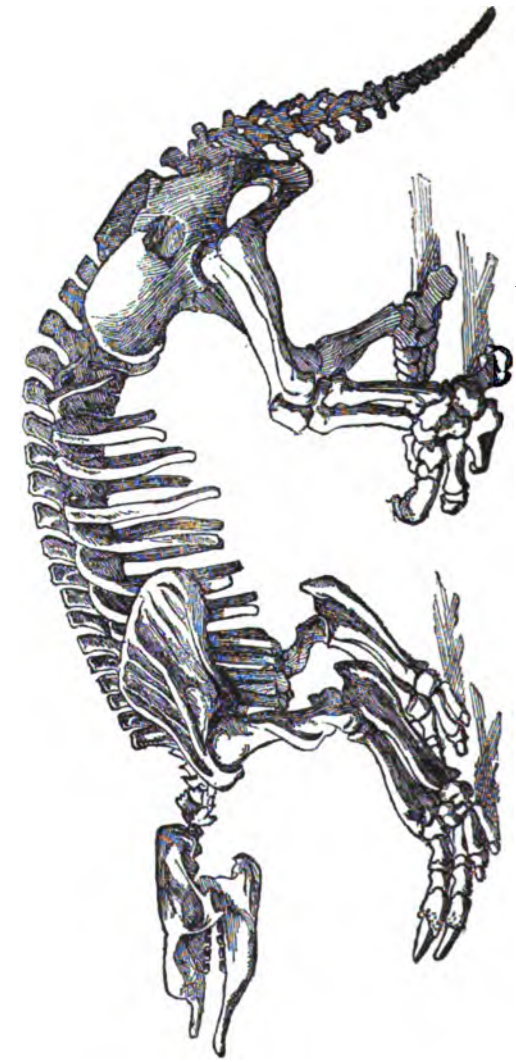


FIG. 68.—**Skeleton of *Scelidotherium leptocephalum*, from the Pampa Formation of Buenos Aires, Argentine Republic; about one-sixteenth nat. size. (Wall-case 26.)**

long, and a slightly restored actual skeleton of ***Mylodon***, somewhat smaller, are mounted on stands marked X, Y, in the attitude which it is believed they usually assumed when

feeding. The original bones and teeth of *Megatherium*, other remains of *Mylodon*, and numerous parts of the skeleton of *Scelidotherium* (Fig. 68) are arranged in Wall-case 26. The bones bear conspicuous crests and ridges, which indicate the muscular power of these animals. The feet are twisted, so that their side rather than their palm would be used when walking; and one, two, or three of the toes on each foot terminate in a great claw. The fore quarters are arranged for the easy motion of the grasping arms. The front of the mandible is spout-shaped (see Figs. 68, 69), evidently adapted to a long protrusible tongue, which could be used like that of a giraffe for pulling leaves off the trees. The few grinding teeth would continually grow as they were worn down throughout life, and those of *Megatherium* (Fig. 69) are made **Stand X. Case Y.** **Stand X.**

FIG. 69.—Lower jaw of *Megatherium americanum*, showing double-ridged molar teeth and long spout-shaped symphysis (*d*), from the Pampa Formation of Buenos Aires, Argentine Republic; one-eighth nat. size. (Wall-case 26.)

extremely powerful by consisting of alternate soft and hard plates of tooth-substance, which produce cross-ridges on the crown.

The skeletons of the ground-sloths are wonderfully well preserved in the Pampa Formation of the Argentine Republic, and it is the rule rather than the exception to find them whole. Most of them are discovered on the borders of old lakes and rivers, evidently in the position in which the animals suddenly died. They are supposed to have perished in the mud and soft ground when attempting to reach the water to drink during dry seasons; for droughts are common even at the present day in the country where they formerly lived. In the time of the ground-sloths, however, the pampa can scarcely have been the bare plain that it is now; it must have borne forest vegetation.

Both human bones and stone implements have occasionally **Table-case 15a.**

Table-case 15a.

been found in the province of Buenos Aires so intimately associated with remains of the ground-sloths that there can be no doubt as to the survival of these gigantic quadrupeds until the time of man at least in the southern part of South America. The most important discoveries, however, which appear to prove this survival, were made in 1897 and subsequent years by Dr. F. P. Moreno, Dr. R. Hauthal, Baron Erland Nordenskjöld, and others, in a cavern near Consuelo Cove, Last Hope Inlet, Patagonia, between the 51st and 52nd degrees of south latitude. Here, in an absolutely dry and powdery deposit on the floor of the large cavern, were found numerous broken bones of several individuals of a ground-sloth, *Grypotherium*, which was nearly as large as *Mylodon* and only differed from the latter in minor features. With the bones were several pieces of skin, evidently of the same animal, which showed marks of tools and seemed to have been stripped off the carcase by man. There were also large lumps of excrement, besides masses of cut grass which may have been intended for fodder. With the *Grypotherium* were found bones of other extinct animals; and in the same cavern there were implements of stone and bone, remains of fires, and even the bones of man himself. The Argentine explorers, in fact, concluded that the *Grypotherium* had actually been kept in the cavern and fed by man, who eventually killed the animals for food.

A series of specimens illustrating this discovery is exhibited in Table-case 15A. The sharply broken bones are remarkably fresh in appearance, still bearing the dried and shrivelled remains of gristle, sinews and flesh. The pieces of skin (Plate IV) are covered with dense, coarse hair on the outside; while the inner layer of their substance is filled with small nodules of bone, which are exposed on the inside where the skin is slightly decayed. Similar little bones have been found in great numbers with the skeletons of

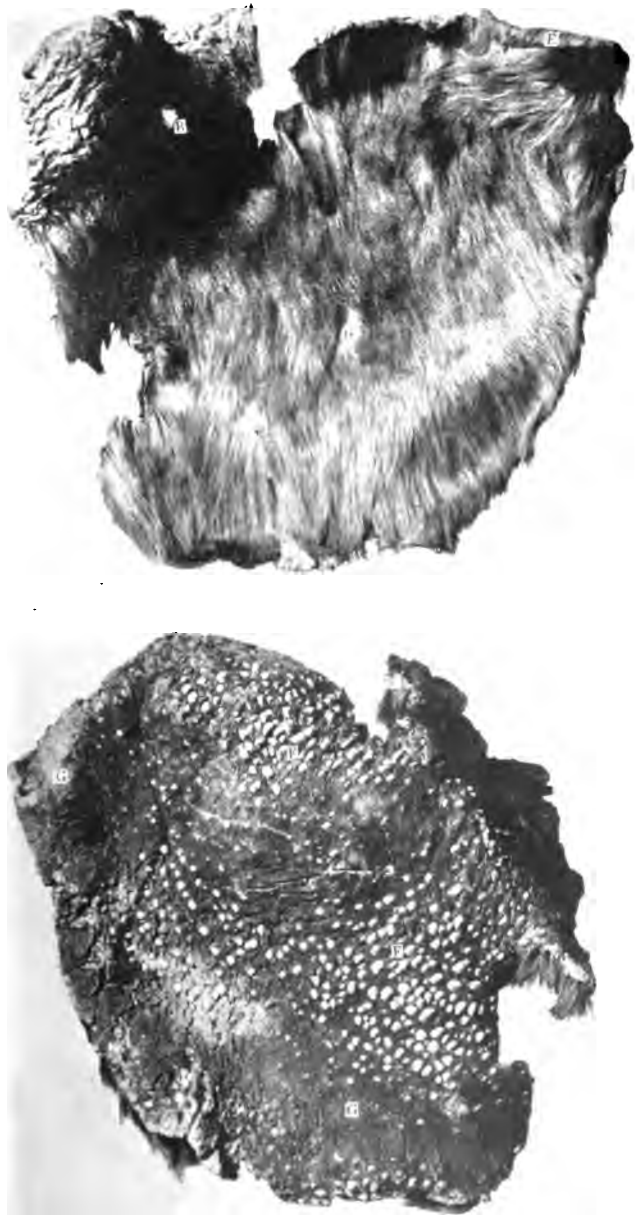
Wall-case 26.

Mylodon in the Pampa Formation (see Wall-case 26), so that this ground-sloth and its allies must have been armoured with a bony mail beneath the hairy outer surface of the skin. The lumps of excrement from the cavern consist only of remains of grass, without any traces of leaves. Among associated animals may be particularly noted the extinct horse, *Onohippidium*, of which there are characteristic teeth besides many well-preserved hoofs.

The **armadillos** which lived with the Pampean ground-sloths, were also gigantic compared with their existing

A

B



Skin of Extinct Ground-sloth (*Grypotherium listai*) from a Cavern near Last Hope Inlet, Patagonia; one-sixth nat. size. The outer side (A) bears coarse hair; the inner side (B) exhibits small nodules of bone imbedded in the substance of the skin. (Table-case 15A.)

[To face p. 74.

representatives. They exhibit great variety, but their coat of mail (carapace) is always rigid, not divided into the over-

Wall-case 26. Table-case 14b. Case Z.

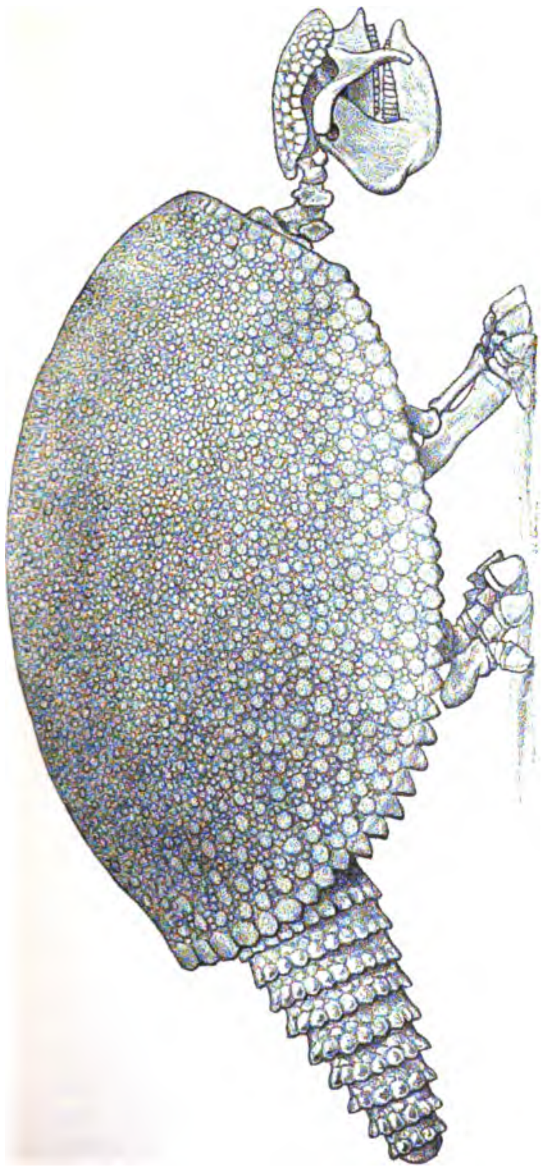


FIG. 70.—Skeleton of *Glyptodon clavipes*, from the Pampa Formation of Buenos Aires, Argentine Republic; one-eighteenth nat. size. (Case Z.)

Wall-case 26. **Table-case 14b.** **Case Z.**

lapping cross-bands which enable the surviving armadillos to roll into a ball when attacked. *Glyptodon* (Fig. 70) is one of the best known genera, and owes its name ("sculptured tooth") to the circumstance that hard and soft portions alternate in the teeth, thus imparting a sculptured appearance to their grinding surface. The actual armour of a fine specimen is mounted, with a plaster cast of the skeleton, in Case Z. As here exhibited the total length of the animal, measured along the curve of the back, is 11 feet 6 inches; while the body shield or carapace measures 7 feet in length by 9 feet across. The armour obviously consists of small bony rosettes or bosses compacted together, and it must have been originally covered with a thin outer skin. There is a little shield on the top of the head; and the covering of the tail is arranged in successive, overlapping rings. At times of danger, the animal would probably be able to draw up its

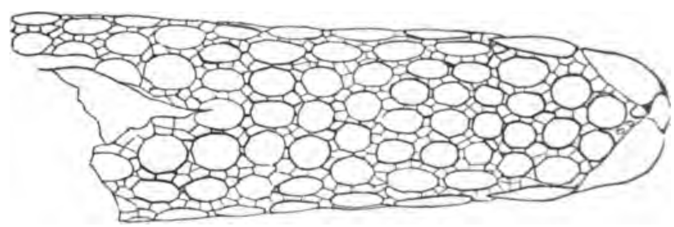


FIG. 71.—Portion of tail-sheath of *Hoplophorus*, from the Pampa Formation of the Argentine Republic; one-quarter nat. size. (Wall-case 26.)

legs close to the body, so as to rest its carapace on the ground, while its armour-plated head would be bent downwards in front. The massive tail must have moved freely behind the carapace, and in one genus, *Daedicurus*, the solid end of the tail-sheath is somewhat expanded to bear a cluster of bony bosses which would give it the aspect of a powerful club (see Wall-case 26). *Hoplophorus* is a smaller elongated animal having the end of the tail-sheath without rings (Fig. 71). It is illustrated by a good series of specimens in Wall-case 26.

Table-case 14b.

The earlier remains of armadillos from Patagonia, as shown by the collection in Table-case 14B, represent animals much smaller than those from the Pampa Formation, and some of them have a banded carapace like that of the living armadillos. It must, in fact, be understood that the tree-sloths of the present South American forests and the

burrowing armadillos of the existing pampa are not the degenerate descendants of the gigantic Pleistocene animals just described. If all their ancestors were known, they would probably prove to have been always small; and they have survived changes which the larger beasts could not withstand, because they exist in comparatively secure retreats and do not need a great amount of food. **Table-case 14b.**

It is sometimes doubted whether the so-called Edentata of the Old World—the **pangolins** and **aard varks**—are really related to the South American animals of this Order. Unfortunately, the known fossils do not help to solve the problem. Some small bones from the Oligocene Phosphorites of France, now in the Paris Museum, seem to belong to ancient pangolins; while skulls, jaws and teeth of the aard vark or Cape anteater (*Orycteropus*), which is now confined to Africa, are exhibited from the Lower Pliocene of Samos, Greece, and Persia (Table-case 14B). No animals ancestral to these are recognisable.

SUB-CLASS II.—METATHERIA.

ORDER X.—**MARSUPIALIA.**

Like the sloths and armadillos of South America, the kangaroos and wombats of Australia were preceded in the Pleistocene period by comparatively gigantic relatives. The largest of these rivalled the rhinoceros in bulk, and its thigh-bone was so completely adapted for the support of a massive body, that when it was first discovered it was mistaken by Owen for the thigh-bone of an elephant. The jaws, however, and other parts of the skeleton soon enabled Owen to publish a satisfactory account of the animal, which he named *Diprotodon* ("two-front-teeth") in allusion to the rabbit-like or wombat-like arrangement of the anterior cutting teeth (incisors). The original specimens from the river deposits of Queensland, many collected by Dr. George Bennett, are arranged in Wall-case 27 and Table-case 15, with the remains of an allied smaller animal, *Nototherium*, from the same region. Notwithstanding its great size, the general shape of *Diprotodon* must have been much like that of the existing wombats of Australia, and it seems to be related both to the phalangers and the kangaroos. The skull (Fig. 72) measures about three feet in length. The grinding teeth are ridged, much like those of a primitive elephant **Wall-case 27. Table-cases 14, 14a, 15.**

Wall-case 27. Table-cases 14, 14a, 15. such as *Dinotherium*. The toes, as proved by complete skeletons discovered some years ago on the dry salt plain bordering Lake Eyre in South Australia, were five in number but remarkably short and slender.

Table-cases 14, 15. The remains of **kangaroos** from the river deposits of Queensland and New South Wales, and from the Wellington Caves, New South Wales, indicate animals of various sizes from that of the smallest living species to that of a donkey. The unique original collection described by Owen is exhibited in Table-cases 14, 15. The largest extinct species referred to *Procoptodon* and *Palorchestes*, though essentially kangaroos, had the fore and hind limbs less disproportionate

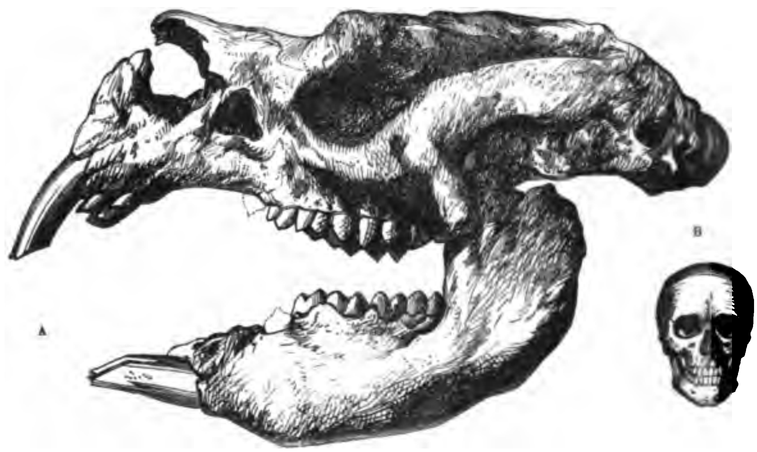


FIG. 72.—Skull and lower jaw of a gigantic extinct Marsupial, *Diprotodon australis*, from the Pleistocene of Queensland; with a Human Skull (B) to show comparative size. (Wall-case 27.)

in size than any living members of the family, and would probably be unable to leap.

Table-case 14a. The largest of the extinct **wombats**, found with *Diprotodon* and the large kangaroos, is *Phascolonus*, of which the lower jaw and upper front teeth are shown in Table-case 14A. It was about as large as an ox. Here are also numerous remains of wombats of more ordinary size.

Table-case 14. The **phalangers** seem to be represented among fossils by the so-called "pouched lion" of Owen, *Thylacoleo carnifex*, which is also found with *Diprotodon* and the large kangaroos in the Australian river deposits and caverns. Numerous unique fragments are exhibited, with a restored model of the

skull and mandible (Fig. 73), in Table-case 14. This animal was regarded by Owen as having preyed upon the large Australian herbivores in the same way that the lion feeds at present on the antelopes and other herbivores in Africa. The lion-like shape of the head and jaws, with the great cutting tooth followed behind by little crushing teeth, seemed to Owen to justify this conclusion. Other naturalists, however, have doubted whether *Thylacoleo* fed on flesh, or at least was more than a mixed feeder, because its large front teeth are incisors, and no known existing carnivore has canine teeth too small for grasping. **Table-case 14.**

The undoubted carnivorous marsupials contemporary with the extinct animals just enumerated, were identical with those still surviving in Tasmania. They are species

Fig. 73.—Skull and lower jaw of *Thylacoleo carnifex*, from the Pleistocene of Australia; one-fifth nat. size. (Table-case 14.)

of the "Tasmanian Wolf" (*Thylacinus*) and the "Tasmanian Devil" (*Sarcophilus*), of which jaws are exhibited in Table-case 14.

Unfortunately no satisfactory remains of mammals are known from rocks below the Pleistocene in the Australian region; and the exact connection between the pouched animals of Australia and the mammals of other parts of the world has not yet been revealed by fossils. It is, however, interesting to notice that the Tasmanian *Thylacinus* and *Sarcophilus* just mentioned are essentially similar to the Creodonta, which flourished in the northern hemisphere at the beginning of the Tertiary period (see p. 16), and to the Sparassodonta, which survived until still later times in South America (see p. 17). It is also worthy of remark that the small pouched opossums, now confined to the American

Table-case 14a. tropics, lived with the Creodonta both in Europe and North America, while other undoubted little pouched animals, such as *Epanorthus*, accompanied the Sparassodonta and early opossums in South America. Jaws of these small marsupials, some from the Lower and Upper Eocene of England, and from the Lower Miocene of France, are shown in Table case 14A. A few South American jaws are arranged with them.

From these and other considerations it seems likely that

FIG. 74.—Lower jaw and teeth of *Triconodon mordax*, from the Purbeck Beds of Swanage; nat. size. (Table-case 14A.)

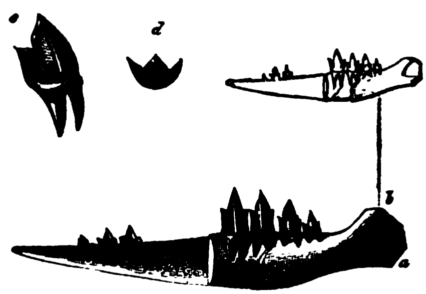


FIG. 75.—Part of lower jaw and teeth of *Spalacotherium tricuspidens*, from the Purbeck Beds of Swanage; outline-fig. nat. size, *c* and *d* being lateral and upper views of a molar tooth. (Table-case 14A.)

the Australian region has remained isolated from the rest of the world since the end of the Secondary epoch, and that its marsupials are the slightly altered survivors of the mammal-life then characteristic of every continent.

Table-case 14a. The only known mammals of the Secondary or Mesozoic epoch are creatures about as large as rats, whose jaws and limb-bones have been found in the Upper Cretaceous and Jurassic rocks of North America, and in the Jurassic (Purbeck Beds and Stonesfield Slate) of England. Most of them seem to have been insectivorous marsupials, and one

jaw of a young *Triconodon* from the Purbeck Beds of Swanage is believed to show a single tooth being replaced in the typical marsupial fashion (see p. 17). The unique collection from the Purbeck Beds, made by Mr. S. H. Beckles, is arranged in Table-case 14B, and comprises several jaws of *Triconodon* (Fig. 74) and *Spalacotherium* (Fig. 75), besides remains of other genera described by Owen in his "Monograph of Mesozoic Mammals" (Palæont. Soc., 1871). With these are some jaws from the Stonesfield Slate, including the original specimen of *Phascolotherium bucklandi* (Fig. 76), Table-case 14a.

FIG. 76.—Lower jaw and teeth of *Phascolotherium bucklandi*, from the Stonesfield Slate of Oxfordshire; outline-fig. nat. size. (Table-case 14A.)

which was so much discussed by Cuvier, Agassiz, and others early in the last century. Drawings of the American Mesozoic jaws are placed with this collection for reference (Fig. 77).

SUB-CLASS III.—PROTOTHERIA.

ORDER XI.—MULTITUBERCULATA.

In some of the jaws of Mesozoic mammals, and in a few similar specimens from the base of the Eocene, both in Europe and North America, there are crushing teeth which bear two or three rows of tubercles or are provided with tubercles round the edge. The otherwise unknown animals to which these jaws belong are named Multituberculata, and they are supposed to be related to the ancestors of the living egg-laying mammals (Monotremata) of the Australian region, because the young *Ornithorhynchus* has somewhat similar multituberculate teeth (see Fig. 82, p. 85).

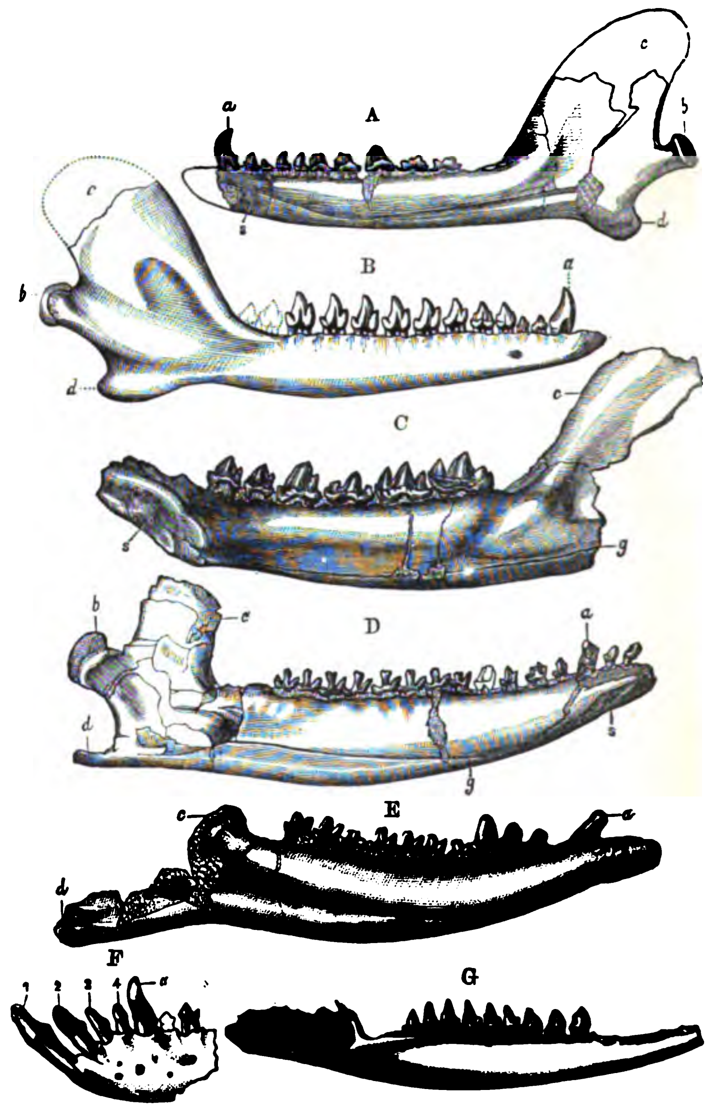


Fig. 77.—Lower jaws of American Jurassic Mammals, from Wyoming, U.S.A.; A, B, twice nat. size; C–F, thrice nat. size; G, four times nat. size. Named by O. C. Marsh as follows:—A. *Docodon striatus*; B. *Dicrocynodon victor*; C. *Priacodon ferox*; D. *Dryolestes priscus*; E. *Dryolestes vorax*; F. *Asthenodon segnis*; G. *Laodon venustus*. *a*, canine; *b*, condyle; *c*, coronoid process; *d*, angle; *g*, mylohyoid groove; *s*, symphysial surface.

The largest of these mammals are represented in the Lower Eocene of New Mexico, U.S.A., by jaws which are named *Polymastodon* in allusion to their "teeth with many nipples." One piece of jaw and two plaster casts of complete jaws are exhibited in Table-case 14A. A much smaller Multituberculate, *Ptilodus*, occurs with *Polymastodon* in New Mexico, while the allied *Neoplagiaulax* (Fig. 78) is found in the Lower Eocene of Rheims, France; but there are no **Table-case 14a.**

FIG. 78.—Upper molar tooth of *Neoplagiaulax eocenus*, grinding surface and two lateral aspects, from the Lower Eocene of Rheims, France; the lower line indicating nat. size. (After Lemoine.)

specimens of these in the collection. Nearly similar teeth and jaws are met with in the Upper Cretaceous Laramie Formation of North America; and others, of the genus *Plagiaulax*, of which several jaws are shown in the Beckles Collection from the Purbeck Beds, have cutting teeth in front and multituberculate teeth only behind (Fig. 79).

Two-rooted multituberculate teeth, belonging to an unknown animal named *Microlestes*, are found even in the

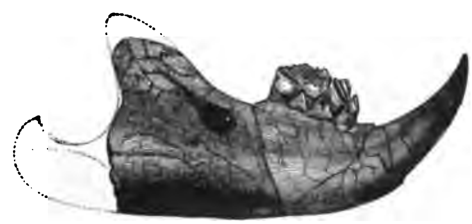


FIG. 79.—Lower jaw and cutting teeth of *Plagiaulax becklesi*, from the Purbeck Beds of Swanage; twice nat. size. (Table-case 14A.)

Rhætic Formation of England and Würtemberg. Specimens of the very small *M. moorei* are exhibited from a Rhætic fissure-deposit at Holwell, near Frome. They bear tubercles round the edge of the crown and closely resemble the hinder teeth of *Plagiaulax*. A skull with multituberculate teeth from the Upper Triassic Karoo Formation of South Africa was also placed here for some time. This (Fig. 81) was described under the name of *Tritylodon longævus* and assigned to a mammal by Owen; while a fore limb from the same formation, named *Theriodesmus phylarchus* by Seeley,

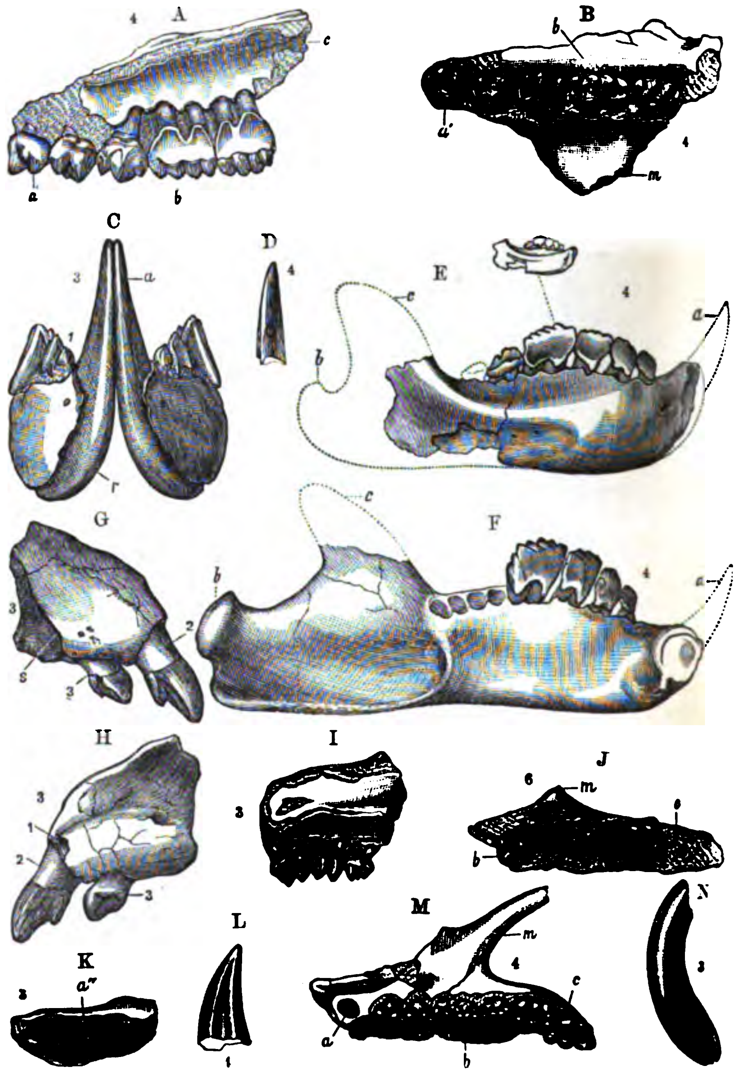


FIG. 80.—Upper and lower jaws of American Jurassic Multituberculata, from Wyoming, U.S.A.; three to six times nat. size, as marked. Named by O. C. Marsh as follows:—A–C. *Ctenacodon potens*; E, F. *Ctenacodon serratus*; G, H, I, K, N. *Allodon fortis*; J, M. *Allodon laticeps*; D, L. incisors of *Ctenacodon*. In upper jaws:—1, 2, 3. incisors; a′, first premolar; *a″*, second premolar; *b*, fourth premolar; *b′*, third premolar; *c*, second true molar; *m*, malar arch; *s*, suture with maxilla. In lower jaws:—*a*, incisor; *b*, condyle; *c*, coronoid process; *r*, root of incisor.

may perhaps belong to a similar animal. In the Triassic period, however, the Theriodont Reptiles so closely approached **Table-case 14a.**

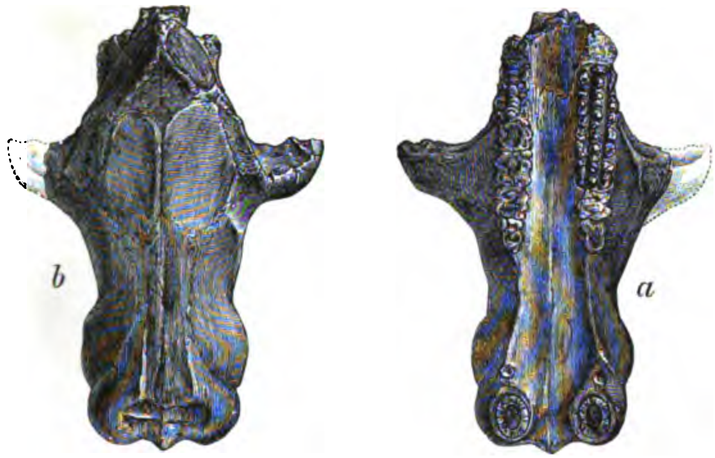


FIG. 81.—Skull of *Tritylodon longævus*, palatal view (*a*) and upper view (*b*), incomplete behind, from the Karoo Formation (Trias) of Basutoland, South Africa; two-thirds nat. size. (Gallery of Fossil Reptiles, Table-case 32.)

the lowest mammals that skeletons alone hardly suffice for the exact determination of their affinities.

Tritylodon and *Theriodesmus* are now arranged with the Theriodonts in the Gallery of Fossil Reptiles (Table-case 32).

ORDER XII.—MONOTREMATA.

The existing monotremes of the Australian region are evidently the much-altered survivors of a very ancient race, and owe their escape from extinction to their small size and burrowing habits. Their predecessors, however, are almost unknown. Plaster casts of some limb-bones of a large *Echidna* from the Wellington Caves, New South Wales, are exhibited in Table-case 14A. **Table-case 14a.**

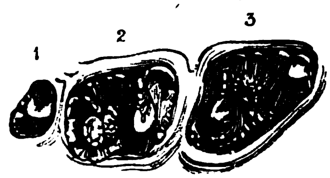


FIG. 82.—Right lower molar teeth of the existing Australian Monotreme (*Ornithorhynchus*), showing their multituberculate crown; three times nat. size. (After C. Stewart.)

Gallery No. 2.—FOSSIL BIRDS.

Remains of birds are very rare among fossils, except in comparatively modern deposits on land; and even under these circumstances they are usually quite fragmentary. They occur most commonly in swamps, such as the English Fenland; in the bed of silted-up lakes; and in caverns and fissures. They are only found by rare accident in the marine deposits of an earlier geological date.

Class.—AVES.

Order I.—**CARINATÆ.**

Table-case 13.

The English Prehistoric and Pleistocene birds, so far as known from the local deposits just mentioned, were essentially similar to those which have lived in this country during historic times. Of special interest, however, is the discovery of remains of the pelican in the Fenland, and in refuse heaps on the site of an ancient British village near Glastonbury (see Table-case 13). It is also worthy of note that the great auk or gare fowl (*Alca impennis*), which became extinct in 1844, has been found in deposits in the north of England, Scotland, and Ireland; and a complete skeleton of this bird, discovered by Professor John Milne in a guano deposit on Funk Island, off Newfoundland, is exhibited in a special Case near the S.E. window.

Among older remains of European flying birds exhibited in Table-case 13, may be noted a leg-bone of an albatross from the Red Crag of Suffolk; bones of flamingo-like birds (*Palælodus*, *Phœnicopterus*), a species of ibis, ducks, and other birds from the Miocene of France; and various eggs and feathers in Miocene freshwater limestones and lignite from France and Germany.

Still older is the unique collection of remains of Lower Eocene birds from the London Clay exhibited in the same Table-case. These fossils chiefly represent fish-eating sea-birds, among which *Odontopteryx* and *Prophaethon* are especially noteworthy. The skull of *Odontopteryx* (Fig. 83) is remarkable for its strongly serrated jaws, the little pointed

processes of bone being doubtless originally covered by Table-case 13.
similar elevations of the horny beak, which would act like teeth in dealing with the slippery prey. This bird was

FIG. 83.—Skull and lower jaw of *Odontopteryx toliapica*, with bony denticles on jaws, from the London Clay of Sheppey; two-thirds nat. size. (Table-case 13.)

probably related to the living gannets. *Prophaethon* resembles a modern frigate bird, but has relatively larger hind legs. Like the other fossils of the London Clay, these birds indicate a subtropical climate in the south of England at the time when they lived here.

From the London Clay there is also part of a large skull named *Dasornis londiniensis* by Owen, who thought it might perhaps belong to a Ratite bird like the ostrich. More satisfactory remains of a large running bird, *Gastornis*, from the Lower Eocene of England, France, and Belgium, suggest affinities with the geese rather than with the ostriches.

The earliest of all true and typical birds hitherto discovered, are represented in Table-case 13 by a few bones of *Enaliornis* from the Cambridge Greensand (Upper Cretaceous) and by vertebræ, a pelvis, and limb-bones, with plaster casts of other bones, of *Hesperornis* from the Chalk of Kansas, U.S.A. The vertebræ with saddle-shaped ends are especially well preserved. These fossils seem to belong to swimming birds like the existing divers (*Colymbus*); and the larger bones from Kansas indicate a species *H. regalis* (Fig. 84), which would measure from three to four feet in height. A large drawing of a skeleton restored by the discoverer, Professor O. C. Marsh, is framed near the window. *Hesperornis* has teeth in a groove in each jaw, though the extremity of its upper jaw is toothless, and would probably be covered with the usual horny beak. The bird must have been flightless, as indicated by its flattened breast-bone (sternum). A

Table-case 13. little flying bird with keeled sternum, *Ichthyornis* (Fig. 85), has also been found in the Kansas Chalk, but is not represented in the collection. Its teeth are in distinct sockets, and some of its vertebræ are biconcave.

FIG. 84.—Skeleton of a toothed flightless bird, *Hesperornis regalis*, from the Cretaceous of Kansas, U.S.A.; about one-eighth nat. size. (After Marsh. See Table-case 13.)

Table-case 13a. Case CC. Among quite recently exterminated Carinatæ from the southern hemisphere, the rails from New Zealand (*Aptornis*),

the Chatham Islands (*Diaphorapteryx*) and Mauritius (*Aphanapteryx*), are of great interest on account of their close resemblance to each other and to the living weka rail (*Ocydromus*) of New Zealand. As they are all unable to fly, Table-case 13a. Case CC.

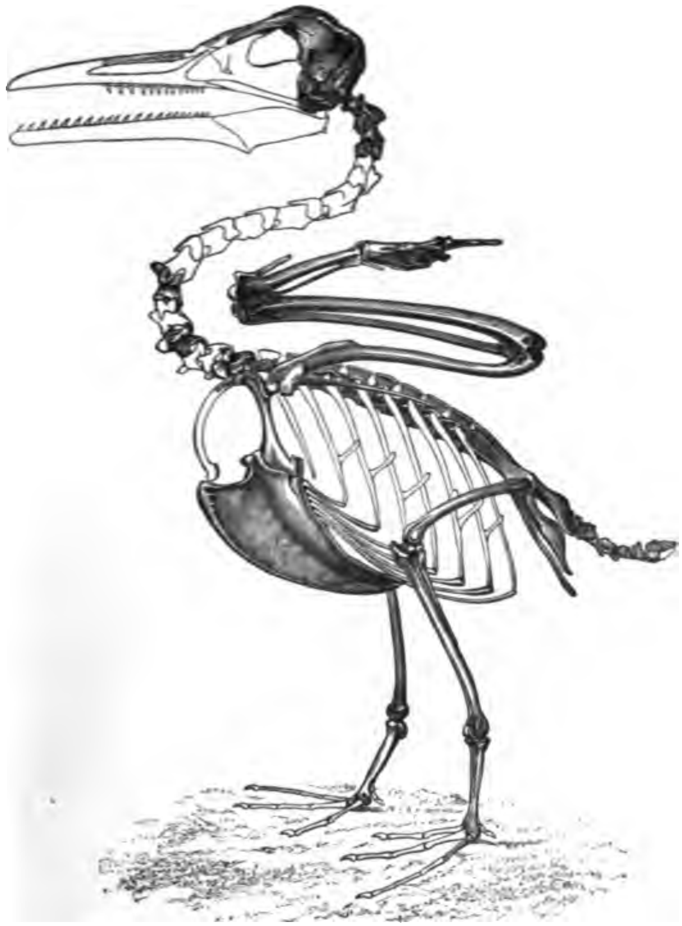


FIG. 85.—Skeleton of a toothed flying bird, *Ichthyornis victor*, from the Cretaceous of Kansas, U.S.A.; one-half nat. size. (After Marsh.)

it is difficult to understand how they reached such widely separated islands, unless these are pieces of a comparatively modern continent which has become submerged. They are

Table-case 13a. Case CC. illustrated by various specimens in Table-case 13A, and by complete skeletons of *Aptornis* and *Diaphorapteryx* in a special Case marked CC.

Case DD. Wall-case 25. With these rails there also lived flightless geese and coots on the islands of the southern Ocean. An incomplete skeleton of the large flightless goose (*Cnemiornis calcitrans*) from New Zealand is mounted in Case DD; and there is a reconstructed skeleton of a coot (*Palæolimnas chathamensis*) from the Chatham Islands in Wall-case 25. Other remains of the same birds and their allied genera are arranged in Table-case 13A. They and the smaller kinds of moas in New Zealand were probably the food of a large and powerful bird of prey (*Harpagornis moorei*), of which the greater part of a

Case EE. skeleton is mounted in Case EE.

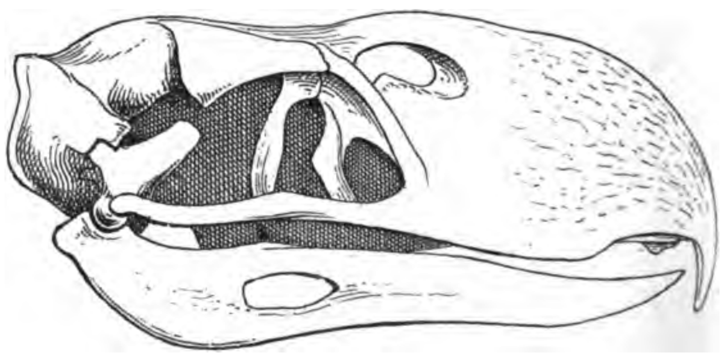


FIG. 86.—Restored skull and lower jaw of *Phororhachos longissimus*, from the Santa Cruz Formation of Patagonia; one-sixth nat. size. (Case AA.)

Wall-case 25. Case BB. A reconstructed skeleton, with plaster casts of the head and foot, of the extinct dodo (*Didus ineptus*) or flightless ground-pigeon of Mauritius, is exhibited in Case BB, and there are other bones in Wall-case 25. This bird, however, is better illustrated in the Department of Zoology, where there is also a skeleton of the allied solitaire (*Pezophaps*) from Rodriguez.

Table-case 12a. Case AA. To a somewhat earlier geological period must be assigned the extinct cariamas and other birds from the Santa Cruz and other Tertiary Formations of Patagonia, which are comprised in the Ameghino Collection in Table-case 12A. *Phororhachos*, the best known genus, is characterised by a very large head and a small body, as shown by the associated

parts of a single individual here exhibited. One of the largest species, *Phororhachos longissimus*, is represented by a nearly complete lower jaw and the sharp tip of the upper jaw, which are enough to justify the model of a restored skull and mandible of this bird mounted in an adjoining special Case (AA). The model (Fig. 86) measures nearly two feet in length, and is much larger than the head of any other known bird. The use of the powerful hooked beak is unknown. **Table-case 12a. Case AA.**

ORDER II.—RATITÆ.

The ostrich-like flightless birds were much more numerous and more widely distributed in the Pleistocene period than they are at the present day. They were especially characteristic of the southern hemisphere, and some of them attained a gigantic size. **Wall-cases 23–25. Table-case 12.**

These birds were most numerously represented in New Zealand, where they survived until the arrival of the Maories, and may even have existed in some places at the time of Captain Cook's visit in 1777. They are referred to in many native legends under the name of "Moa," but they remained unknown to science until 1839, when the shaft of a small thigh-bone, now exhibited in Table-case 12, was described by Owen. He recognised that this bone belonged to a flightless bird of a heavier and more sluggish kind than the ostrich, which he proposed to name *Dinornis struthioides* ("terrible bird like an ostrich"). By the exertions of the Hon. Walter Mantell and numerous later explorers a wonderful series of Dinornithidæ of many genera, species, and varieties has gradually been discovered, and these birds are now well represented in the collection. Of the largest species, *Dinornis maximus*, there is a nearly complete skeleton of one individual 8 ft. 6 in. in height in Case GG (see Plate V). **Case GG.** With this is placed another complete skeleton of one of the smallest species, *Anomalopteryx parva*, only three feet in height. There is also a stuffed specimen of a kiwi (*Apteryx*), which is the sole survivor of the Ratitæ in New Zealand at the present day. In boxes on the floor of the case are some of the bony rings of the windpipe found with the fossil skeletons. The skeleton of a medium-sized bird with very stout legs, *Pachyornis elephantopus*, is mounted in Case FF, and in front of this there is a small slab of sandstone from a hardened beach bearing the footprint of one of the moas. **Case FF.** Skeletons of two more slender small species,

Case HH. *Anomalopteryx didiformis* and *Emeus gravipes*, are exhibited in Case HH. There are also various more fragmentary **Wall-cases 23, 24. Table-case 12.** specimens of Dinornithidæ in Wall-cases 23 and 24 and in Table-case 12. In the latter may be noticed, besides eggs and feathers, the mummified remains of the head, neck and legs of a small species from a very dry fissure-cavern in Otago. This specimen shows, in addition to the skin, the bony (sclerotic) plates round the eye, the tracheal rings of the windpipe, and the sheath of the claws. Many of the more fragmentary bones were obtained from the old cooking-places of the Maories, who seem to have hunted and fed upon the moas.

Case GG. As shown by the fine skeleton of *Dinornis maximus* (Plate V), the wing is more reduced in the Dinornithidæ than in any other known birds. There is nothing beyond a small scapulo-coracoid bone, which does not even bear a socket for the limb. The feathers agree much more closely with those of the Australian emus and cassowaries than with those of the New Zealand kiwis.

In the Australian region there were emus in the Pleistocene period. There was also another large Ratite bird, *Genyornis newtoni*, of which remains have been discovered near Lake Callabonna, South Australia. As shown by a **Wall-case 24.** hind limb in Wall-case 24, it had three remarkably slender toes. It lived with the small-toed *Diprotodon* already mentioned (p. 78).

Ratite birds were also abundant in Madagascar at a quite recent geological period, although none now survive in that island. They seem to have been most closely similar to the *Apteryx* and moas of New Zealand, and one species, *Aepyornis* **Wall-case 25. Case II.** *titan*, of which there are limb bones in Wall-case 25, probably exceeded in size the largest of the New Zealand birds. A specimen of moderate dimensions, *Aepyornis hildebrandti*, is represented in Case II by a reconstructed skeleton, which exhibits a short and broad breastbone, like that of *Apteryx*, with remains of a very small wing. Eggs of *Aepyornis* are not uncommon in the sand bordering the lakes of Madagascar, and they are sometimes washed out during stormy weather. Under these circumstances they float on the water and are picked up by the natives. Fine examples are shown in Case II. The largest measures three feet in its largest circumference by two feet six inches in girth, and its liquid contents would equal a little more than two gallons. Such eggs would probably be laid by the largest species, *Aepyornis titan* and

Skeleton of the Gigantic Moa (*Dinornis maximus*) from New Zealand; one-seventeenth nat. size. (Case HH.)

[*To face p. 92.*

A. maximus, but it is worthy of note that in the New Zealand *Apteryx* the egg is enormous compared with the size of the bird which lays it (see Case GG). **Wall-case 25. Case II.**

The living rheas of South America were preceded in the Tertiary period by large birds like *Brontornis*, of which plaster casts of limb bones are exhibited in Wall-case 25. The two-toed ostriches, which are now confined to Africa and Arabia, ranged into the Indian and south-eastern European regions in Pliocene times. Remains of *Struthio asiaticus* from the Siwalik Formation of India are placed with the skeleton of a modern ostrich in Case JJ. A small piece of limb bone from the Eocene of the Fayum, Egypt, exhibited in Table-case 12, probably represents an ancestor of the ostriches, which has been named *Eremopezus eocaenus*. **Wall-case 25.** **Case JJ.**

ORDER III.—SAURURÆ.

Birds are proved by their structure to be closely related to reptiles; and many of the extinct reptiles exhibit peculiarities which are now exclusively confined to birds. It is therefore interesting to observe that the oldest known birds, which date back to the latter part of the Jurassic period, approach the reptiles more nearly than any existing birds in at least four respects. They are peculiar in (1) the possession of true teeth, (2) the biconcave or flat-ended shape of their vertebræ, (3) the completeness of three clawed fingers in the wing, and (4) the elongated, not tufted, shape of the tail. In allusion to the last-mentioned feature they are named Saururæ ("lizard-tails"). **Table-case 13.**

Of these primitive birds only two satisfactory specimens have hitherto been discovered, both in the Lithographic Stone of Bavaria, which is of the same geological age as the Kimmeridge Clay of England. They seem to belong to two species of one genus, and the first specimen, representing *Archæopteryx macrura* of Owen, is shown in Table-case 13. The piece of limestone in which the skeleton is preserved has split along the plane of weakness caused by the presence of the fossil itself, so that some of the bones adhere to one face while other portions are retained by the counterpart slab. It is thus necessary to exhibit the two slabs side by side, the one supplementing the other. As shown by the accompanying photograph (Plate VI) and the explanatory diagram (Fig. 87), there is a typical bird's "merrythought" (furcula)

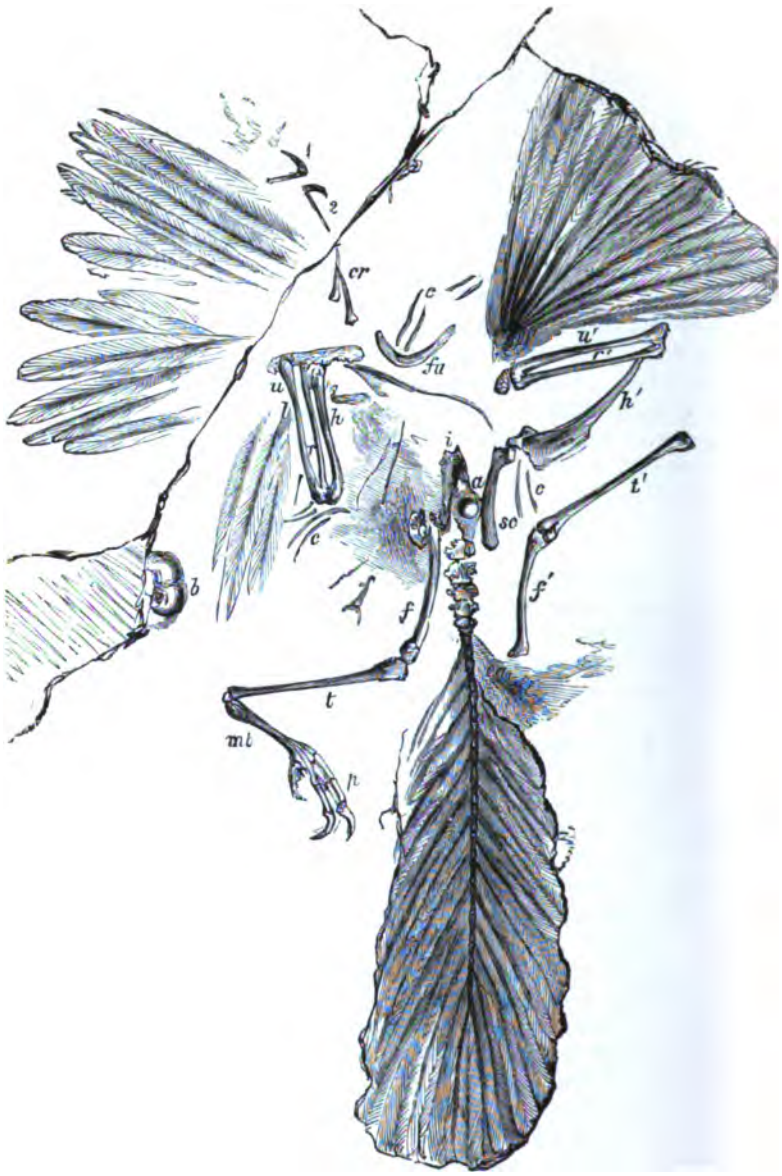


Fig. 87.—Diagrammatic sketch of the fossil lizard-tailed bird, *Archæopteryx macrura*, from the Lithographic Stone (Upper Jurassic) of Eichstädt, Bavaria; about one-quarter nat. size. *a*, acetabulum; *b*, cast of brain-cavity of skull; *c*, ribs; *cr*, carpals; *f*, femur; *fu*, furcula; *h*, humerus; *i*, ischium; *mt*, tarsometatarsus; *p*, phalanges of foot; *r*, radius; *sc*, scapula; *t*, tibia; *u*, ulna; 1, 2, phalanges of hand. (Table-case 13.)

Fossil Lizard-tailed Bird, *Archæopteryx macrura*, from the Lithographic Stone (Upper Jurassic) of Eichstädt, Bavaria; about one-quarter nat. size. (Table-case 13.)

[*To face p.* 94.

between the wings; and the hind leg is exactly that of a perching bird. The long tail, however, comprises a row of twenty slender vertebræ, each bearing a pair of feathers. Owing to the fine grain of the stone, the feathers both of the wings and the tail are perfectly displayed in impressions, which were made when the actual feathers were originally buried in the soft limy mud. **Table-case 13.**

Of the second specimen of the *Archæopteryx*, now in the Berlin Museum, a plaster cast is placed next to the first example in Table-case 13. It retains the head, which is quite bird-shaped, though its jaws are provided with teeth

FIG. 88.—Skull and lower jaw of *Archæopteryx siemensi*, showing teeth, from the Lithographic Stone (Upper Jurassic) of Eichstädt, Bavaria; nat. size. (After Dames. Original in Berlin Museum, plaster cast in Table-case 13.)

in sockets (Fig. 88). It also exhibits the three clawed fingers of the wing. A photograph of the specimen is fixed head downwards on the wall near the window, to show the lizard-like sprawl assumed by the skeleton at the time it was buried.

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R.

S.

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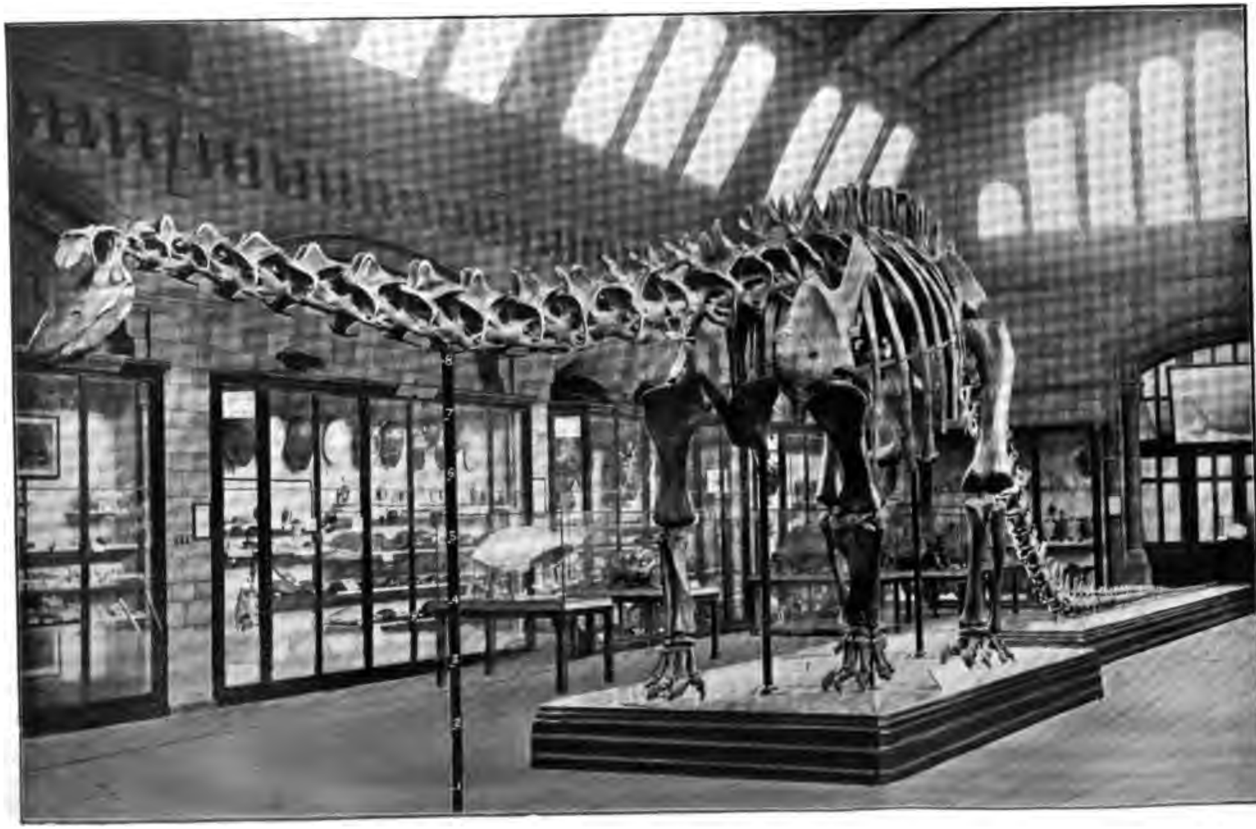

THE REPTILE GALLERY, VIEWED FROM THE SOUTH-EAST, SHOWING THE MODEL OF THE SKELETON OF *Diplodocus carnegii.*

[*Frontispiece.*

7

GUIDE

TO THE

GALLERY OF

REPTILIA AND AMPHIBIA

IN THE

DEPARTMENT OF ZOOLOGY

OF THE

BRITISH MUSEUM (NATURAL HISTORY)

CROMWELL ROAD, LONDON, S.W.

ILLUSTRATED BY 76 TEXT AND OTHER FIGURES

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1906

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PREFACE

THE Reptilian Gallery in the Zoological Department of the Museum is primarily devoted to the exhibition of specimens of recent Reptilia and Amphibia, the extinct forms being displayed in a gallery in the Geological Department, to which there is a special guide-book. Recent Reptiles cannot, however, be understood without some knowledge of the extinct kinds; and it has accordingly been deemed advisable to exhibit specimens of a few characteristic examples of each of the more important extinct groups. In addition to these, from considerations of space, the skeleton of the great Dinosaur *Diplodocus* presented by Mr. Andrew Carnegie is exhibited in this gallery.

The specimens are numbered consecutively, commencing with the Crocodilia and going round the gallery to the Chamæleons. After the latter come the Amphibia. The groups are not described in quite the same sequence in this Guide; at the same time every specimen is numbered, and the corresponding number can be found in the Guide without any difficulty.

It must be remembered that only a few selected species are exhibited in this gallery, and that the bulk of the Museum collection of Reptiles and Amphibians is preserved in the spirit-house and

store-rooms, to which this Guide does not refer. The process-blocks are from photographs of actual specimens in the Museum, and were prepared under my immediate superintendence. The Guide has been written by Mr. R. Lydekker, F.R.S. Some of the woodcuts are borrowed from the 'Cambridge Natural History,' others are from publications already issued by the Trustees.

E. RAY LANKESTER,

DIRECTOR.

BRITISH MUSEUM (NATURAL HISTORY),
LONDON, S.W.
March 7th, 1906.

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Class AMPHIBIA, or BATRACHIA.

GUIDE

TO THE

[redacted]

CORRIGENDA.

Page 9, line 16 from top, *for* fifth *read* ninth.
" 28, " 6 " bottom, *for* All *read* Nearly all.
" 35, " 18 " top, *for* All *read* Most.
" 69, " 21 " top, *for* always *read* usually.

The first class—Reptilia—comprises the true Reptiles, such as crocodiles, snakes, lizards, and tortoises, and is characterised by the fact that the young (whether hatched from eggs or born alive) resemble their parents in most things except size and, perhaps, some details of colouring, as soon as they come into the world and breathe atmospheric air. Another feature is that the skull is attached movably to the first joint of the back-bone, or first vertebra, by means of a single knob, or "condyle" (fig. 1, *a*), which usually consists of three separate portions, one in the middle and two at the sides. In the presence of this single knob Reptiles resemble Birds and differ from Mammals. They also agree with the former and differ from the latter in that the lower jaw consists of a number of separate pieces and is joined to the skull by means of an extra bone, the quadrate-bone (fig. 1, *q*).

The second class—Amphibia—includes, on the other hand, such creatures as newts, salamanders, frogs, and toads, in the great

GUIDE

TO THE

REPTILES AND AMPHIBIANS.

I.—THE REPTILE SERIES.

Class REPTILIA.

ACCORDING to popular ideas, all cold-blooded vertebrate (back-boned) animals which do not come under the designation of Fishes are denominated Reptiles. The naturalist, on the other hand, divides these creatures into two main groups or classes, each of which is of equivalent rank to the Mammalia (Mammals) or Aves (Birds).

The first class—Reptilia—comprises the true Reptiles, such as crocodiles, snakes, lizards, and tortoises, and is characterised by the fact that the young (whether hatched from eggs or born alive) resemble their parents in most things except size and, perhaps, some details of colouring, as soon as they come into the world and breathe atmospheric air. Another feature is that the skull is attached movably to the first joint of the back-bone, or first vertebra, by means of a single knob, or "condyle" (fig. 1, *a*), which usually consists of three separate portions, one in the middle and two at the sides. In the presence of this single knob Reptiles resemble Birds and differ from Mammals. They also agree with the former and differ from the latter in that the lower jaw consists of a number of separate pieces and is joined to the skull by means of an extra bone, the quadrate-bone (fig. 1, *q*).

The second class—Amphibia—includes, on the other hand, such creatures as newts, salamanders, frogs, and toads, in the great

majority of which the young come into the world as aquatic animals ("tadpoles"), breathing the air dissolved in water by means of gills, but subsequently undergo a marked change (metamorphosis) into the adult form, when atmospheric air is breathed by means of lungs. It is true that in some cases the gill-bearing tadpole form is retained throughout life (the creature breeding in this condition), and also that in other instances the animal comes into the world in the permanent air-breathing condition. In the latter case the larval stages are passed through within the body of the

Fig. 1.

Back view of Skull of Crocodile, without the lower jaw. To show the single knob, or "condyle" (*o*), by which the skull is articulated to the first joint of the back-bone, or vertebral column; and the quadrate-bone (*q*), to the lower end of which the lower jaw would be attached.

female parent or, more rarely, within the shell of an egg which is laid (Cæcilians). In existing Amphibians the skull is articulated to the first vertebra by means of two knobs, or "condyles," as in Mammals.

At the present day Reptiles and Amphibians are sharply distinguished from one another, and while the former show many decided relationships to Birds (still more emphasised in some of their extinct predecessors), the latter do not exhibit any such affinity.

When, however, extinct Reptiles and Amphibians are taken into

consideration, it is found that there are close approximations between the two classes, and that the one group is probably descended from the other. The descent is, however, not apparently to be traced through a single line. On the contrary, while the great majority of Reptiles seem to trace their origin to one extinct group of Amphibians (the Microsauria), one particular extinct group of the former, namely, the Theromorpha, shows evidence of descent from a second group of Amphibians (the Labyrinthodonta). From the first great branch of Reptilia, which includes all the "orders" in the following table except the last, Birds seem to have been derived; so that the whole assemblage may be termed the Bird-like Reptiles.

The tenth order of Reptiles, on the other hand, which has been long since extinct, exhibits remarkable indications of affinity with Mammals, this being displayed in the character of the teeth, of the skull, and of the limb-bones; and it is probable that this group represents the ancestral stock from which Mammals are derived. Indeed, there are certain South African fossils in regard to which it is difficult to say whether they should be referred to Reptiles or Mammals.

The following table exhibits the chief sub-divisions of the class Reptilia, that is to say, the orders and sub-orders under which the various families are arranged. Those groups which are extinct are indicated by a †; and it will be noticed that the proportion of these extinct groups is very large indeed—much larger than in the case of either Mammals or Birds. The explanation of this is that Reptiles are a very ancient group, which attained its maximum development when Mammals and Birds were in their infancy; hence the extinction of a large number of groups.

CLASSIFICATION OF REPTILIA.

	Order.	Sub-order.	Case.
Bird-like Reptiles.	I. †Ornithosauria (Pterodactyles.)	. . . .	4
	II. †Dinosauria (Dinosaurs.)	1. Theropoda 2. Sauropoda 3. Ornithopoda	4
	III. Crocodilia, or Emydosauria (Crocodiles.)	1. Eusuchia 2. †Aëtosauria 3. †Parasuchia, or Phytosauria.	1–3

CLASSIFICATION OF REPTILIA—*continued.*

	Order.	Sub-order	Case.
Bird-like Reptiles.	IV. Rhynchocephalia (Tuateras.)	1. †Protorosauria. 2. Rhynchocephalia Vera 3. †Acrosauria	5
	V. †Pelycosauria	. . . .	5
	VI. Squamata (Snakes and Lizards.)	1. Ophidia 2. Lacertilia 3. Rhiptogilossa 4. †Dolichosauria 5. †Pythonomorpha	11–20
	VII. †Ichthyopterygia (Ichthyosaurs.)	. . . .	17
	VIII. Chelonia (Tortoises and Turtles.)	1. Atheeæ 2. Cryptodira 3. Pleurodira 4. †Amphichelydia 5. Trionychoidia	6–10
	IX. †Sauropterygia (Pleriosaurs.)	. . . .	16
	[†Placodontia]	Of uncertain position	5
Mammal-like Reptiles.	X. †Theromorpha (Anomodonts.)	1. Dicynodontia 2. Theriodontia 3. Cotylosauria 4. Pariasauria	5

In the gallery the larger specimens are arranged either on stands or in table-cases, and the rest in the wall-cases. Owing to differences in the sizes of the wall-cases, it has not, however, been found possible to make the serial arrangement of the various groups correspond exactly with the one adopted in this guide.

The following is a brief survey of the leading characteristics of the different orders and sub-orders of reptiles, and also of the more important family groups by which existing orders and sub-orders are represented.

Order I.—ORNITHOSAURIA (*extinct*).
(Case 4.)

Pterodactyles, as the members of this extinct order are called, flourished during the Mesozoic, or Secondary, epoch, and are distinguished by the modification of the fore-limbs into wings, the

Fig. 2.

Fig. 3.

Fig. 4.

Figs. 2, 3, 4.—Right Wings of a Pterodactyle (2), a Bird (3), and a Bat (4).
To show difference in structure of Skeleton.
(From Lankester's "Extinct Animals.")

[To face page 5.

membrane of which was attached to the side of the body and supported by the elongated outermost digit, or finger (fig. 2). They are further characterised by the fixed quadrate-bone and the double temporal arches of the bird-like skull. The teeth, when present, are conical and implanted in distinct sockets confined to the margins of the jaws.

Fig. 5.

Restoration of a Long-tailed Pterodactyle (*Rhamphorhynchus phyllurus*), from the Upper Jurassic Lithographic Stone of Bavaria; one-seventh nat. size.

There are only four digits in the fore-limb, but five in the hind-one. Many of the bones are hollow. The tail is of variable length; in the long-tailed *Rhamphorhynchus* (**38**) it terminated in a racket-shaped membranous expansion. In *Pterodactylus*, *Rhamphorhynchus* (**36**), and *Scaphognathus* (**36** and **37**) teeth are present, but they are wanting in *Pteranodon* of the Cretaceous, some of the species of which had a wing-spread of twenty feet. In spite of certain resemblances, Pterodactyles have no affinity to Birds, as is shown by the difference in the structure of the wing (figs. 2 and 3).

Order II.—DINOSAURIA (*extinct*).

(Case 4 and middle of gallery.)

The members of this order, which includes the largest of all known land animals, are confined (in the main, at least) to the Mesozoic, or Secondary, period of geological history, and thus ceased to exist many thousands of years before man made his appearance on the globe. In most characters Dinosaurs are closely allied to Crocodiles, with the typical forms of which they agree in the fixed quadrate-bone and the double temporal arches of the skull, the restriction of the teeth, which may be implanted in distinct sockets,

to the margins of the jaws, the two-headed ribs, the absence of a perforation in the lower end of the humerus, and the adaptation of the limbs for walking.

They differ in that the ischia, or posterior elements of the lower part of the pelvis, unite in the middle line of the abdomen, and by the circumstance that when the vertebræ articulate by cup-and-ball joints, the cup (except occasionally in the tail) is behind (opisthocœlous). No Dinosaurs have the pitted bony plates found in most Crocodiles.

The group is divided into four sub-orders :—

I. SAUROPODA.—Includes gigantic herbivorous, plantigrade Reptiles, walking on all four limbs, with teeth in the front of both jaws, the pubes of the pelvis simple and meeting in the middle line of the abdomen, and the trunk-vertebræ with lateral cavities. The teeth are spatulate, with smooth edges. Some of the species, like *Brontosaurus*, were about sixty feet in length and ten in height. Generally, as in *Cardiodon* (*Cetiosaurus*) and *Diplodocus* (**41**), the skull is small.

II. THEROPODA.—The members of this group differ from the Sauropoda by their digitigrade feet, carnivorous habits, laterally-compressed and serrated teeth, and the absence of excavations in the trunk-vertebræ. Many of them, like *Megalosaurus* (**39**) and the diminutive *Compsognathus*, assumed the erect posture.

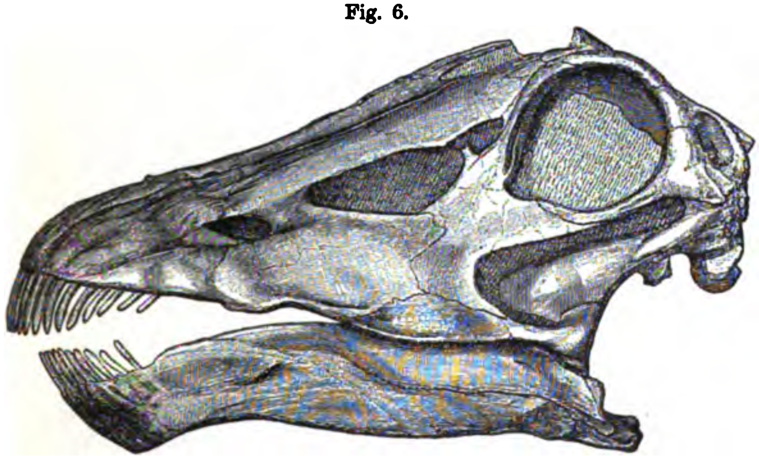
III. ORNITHOPODA.—The division of the pubis into a pre-pubic and a post-pubic branch, neither of which meets in the middle line of the abdomen, forms a distinctive feature of this group, in which the front of both jaws is devoid of teeth, while the lower jaw is provided with a distinct premandibular bone. Teeth complicated, seldom in separate sockets. All the forms are herbivorous. In one section (Stegosauria) the feet are plantigrade, with more than three toes, the limb-bones are solid, and bony plates and spines protect the body. *Scelidosaurus* (**42**), *Stegosaurus*, and *Hylæosaurus* are well-known genera. In a second section (Iguanodontia) the hind-feet are digitigrade, with three functional toes, the limb-bones hollow, and the body unarmoured. The group includes *Iguanodon* (**43**), *Camptosaurus*, *Trachodon*, etc., all bipedal.

IV. CERATOPSIA.—Includes gigantic quadrupedal Reptiles, with a bony neck-shield, a premandibular and a prerostral bone, a

pubis with only a pre-pubic branch, meeting its fellow in the middle line, two-rooted teeth implanted in sockets, and plantigrade, five-toed limbs. Bony plates are dotted over the skin. *Triceratops*, of the North American Cretaceous, is a well-known type.

Casts of specimens of a few remains of different members of the group are exhibited in Wall-Case No. 4, in which there is also a miniature restoration of the species known as *Diplodocus* (**41**). Of the

Fig. 6.



Side view of Skull of a Sauropod Dinosaur (*Diplodocus*), from the Upper Jurassic strata of Colorado, U.S.A.; one-sixth nat. size. The cleft at the summit of the head is the nostril, and the large round vacuity the eye-socket. The diminutive brain-case is behind and partly between the eye-sockets. (No. **47**.)

latter animal, the cast of an entire skeleton, the gift of Mr. Andrew Carnegie, is mounted in the middle of the gallery (*see* Frontispiece).

Diplodocus is a representative of the Sauropod section, which includes the largest of all land-Reptiles, and flourished during the Jurassic and Lower Cretaceous epochs, that is to say, when the Oolites, Wealden, and Greensands were being deposited. These Reptiles walked on all fours; but, despite the light construction of the neck and trunk-vertebræ, were probably too heavy for much activity on land, and dwelt near the sea or lakes, where they lived in the shallows and fed on water-plants; the long neck and the position of the nostrils at the summit of the skull enabling them to breathe when wading at considerable depths. *Brontosaurus* and *Atlantosaurus*

are other American members of the group, which was represented in England by *Pelorosaurus*, *Cetiosaurus*, and *Hoplosaurus* or *Ornithopsis*. Remains of these are shown in the Geological Department.

Order III.—CROCODILIA.

(Cases 1–3.)

The existing Alligators, Crocodiles, and Gharials, collectively forming this order, are large, four-footed, long-tailed reptiles, with teeth implanted in separate sockets, which are confined to the margins of the jaws, and the quadrate-bone firmly fixed to the skull. The bones of the skull are sculptured, and the body is covered with large, horny shields, underlain on the back, and sometimes on the chest, abdomen, and limbs, by pitted bony plates. The inner aperture of the nostrils is situated very far back on the palate, thus enabling these reptiles to breathe while holding their prey under water. There are five toes to the fore-feet, and four to the hind-pair.

In the skeleton, the bodies of the vertebræ unite by a ball-and-socket joint, of which the ball is behind; and the ribs articulate to the vertebræ by two distinct heads.

Species of true Crocodiles are found living in the New World as well as in Africa and Asia; the Alligators, with the exception of one Chinese species, are American only, and the Gharials are Indian.

In the earlier extinct members of the group, most of which were marine, the inner aperture of the nostrils is situated less far back on the palate; and the vertebræ articulate with each other by nearly flat or slightly cupped surfaces. A few of the early forms—notably the Jurassic *Metriorhynchus* and *Geosaurus*—had no bony plates on the back. The early Crocodilia include long-snouted (*Pelagosaurus*, **2**) and short-snouted types (*Goniopholis*, **4**), which may perhaps have respectively given rise to the modern Gharials and Crocodiles. In these Jurassic Crocodiles the position of the posterior nostrils is intermediate between that obtaining in modern Crocodiles and the Triassic Parasuchia (*Phytosaurus*, **1**), in which last they open almost immediately below the external nostrils. These very primitive Crocodilia show such a decided approximation to the extinct Dinosauria as to indicate a close connection between the two groups; they are also related to the Rhynchocephalia.

The family *Crocodilidæ* is taken to include all the existing members of the order Crocodilia. The group is characterised by the bodies of the neck-vertebræ articulating by cup-and-ball joints,

FIG. 7.

VIEW FROM ABOVE OF THE SKULL OF THE MUGGER OR INDIAN CROCODILE
(*Crocodilus palustris*).
× Fourth lower tooth.
(Photographed from a specimen in the Museum.)

FIG. 8.

SIDE VIEW FROM ABOVE OF THE SKULL OF A S. AMERICAN ALLIGATOR
(*Caiman niger*).
(Photographed from a specimen in the Museum.)

[*To face page* 8.

of which the ball is behind and the cup in front (*procœlous*). The nostrils are situated at the extremity of the snout, and their posterior openings (*choanæ*) carried back to the hinder extremity of the skull, the palatine and pterygoid bones developing inferior plates, which meet in the middle line and thus prolong the nasal passage. The armour consists of more than one pair of longitudinal rows of plates on the back; on the under surface of the body armour may or may not be present.

In common with Alligators and Caimans, true Crocodiles are Cases 1–2.
distinguished by the shortness and breadth of the muzzle, which is either rounded-off or triangular, and the large and stout teeth, which interlock with one another and are less numerous than in the Gharials. The union (symphysis) between the two halves of the lower jaw is also short, and does not include the splenial bone; and the nasal bones enter the aperture of the nostrils. In Crocodiles the fourth lower tooth is received into a notch in the upper jaw (figs. 7 and 9), and the fifth upper tooth is the largest in the whole series. The number of upper teeth ranges from 16 to 19, and there are 14 or 15 lower teeth on each side. There is no bony armour on the under side of the body.

Crocodiles have a much wider geographical distribution than any other members of the order. Three species, *Crocodilus cataphractus* (**10**), *C. johnstoni* (**9**), and *C. intermedius*, have longer and more Gharial-like muzzles than the rest. Other species, like the American Crocodile (*C. americanus*, **16**), the Timsa, or Common African Crocodile (*C. niloticus*, **14**), and the Indian Estuarine Crocodile (*C. porosus*, **19**), have somewhat shorter and broader muzzles. In a third group, which includes the Muggar, or Indian Marsh-Crocodile (*C. palustris*, **20**), the muzzle is still broader and more Alligator-like, and the pits in the temples are smaller than in the other groups. One species, the West African *Osteolæmus tetraspis* (**3**), is assigned to a separate genus on account of the production of the nasal bones to divide the aperture of the nostrils.

Together with Alligators and Caimans, Crocodiles are the largest and most ferocious of living reptiles; the Indian *C. porosus* commonly attaining a length of from 15 to 20 feet, and occasionally reaching even larger dimensions. Most of the species frequent rivers, marshes, or pools, but *C. porosus* inhabits estuaries, and may be met with out at sea. Crocodiles are exclusively carnivorous, and generally seize their victims (other than human beings) by the nose as they are drinking. A large number of people—especially women, as they go to the rivers for water—are annually killed in India by

these Reptiles. Crocodiles bury their eggs in the sand, where they are hatched by the heat of the sun's rays.

Four large specimens are exhibited on a stand in the middle of the gallery, and the others in the wall-cases.

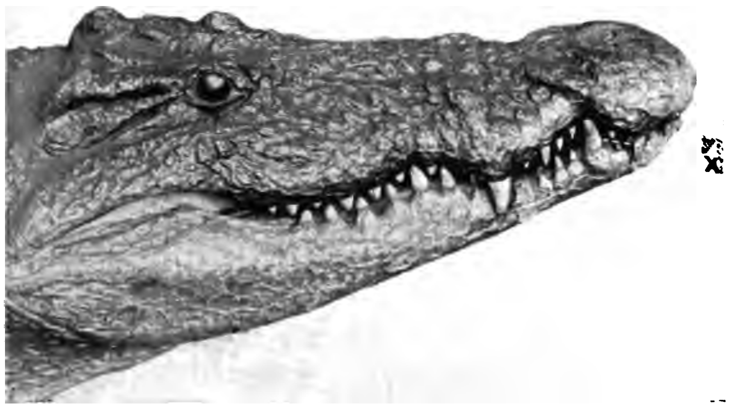
Case 3. In case No. 3, two specimens are placed side by side in order to show a notable difference between the skull of a Crocodile and an Alligator (figs. 7 and 8). In the former (**14** *a*) the fourth lower tooth is generally received into a notch on the side of the upper jaw, while in the latter (**28** *a*) it bites into a pit. Crocodiles have also fewer lower teeth than Alligators; the number in the former varying from 14 to 15, and in the latter from 17 to 22. In most Crocodiles the skull is narrower than in Alligators, with the pits in the temporal region (shown in the specimens in the upper part of the case) larger, but, as mentioned above, some species of the former approximate very closely to the latter in these respects.

Case 3. Alligators and Caimans are broad-nosed Crocodilians, distinguished from Crocodiles, as stated above, by the fourth lower tooth being generally received into a pit in the upper jaw, and the small size or obliteration of the pits in the temples; the number of teeth being from 17 to 20 in the upper, and from 17 to 22 in the lower jaw. In the true Alligators the nasal bones divide the aperture of the nostrils, the bony plates on the back are separate, and on the under surface these are either very thin or wanting. In the Caimans, or South American Alligators, on the other hand, the aperture of the nostrils is not divided by the nasal bones, the bony plates of the back are articulated together, and a full series of similar plates occurs on the lower surface of the body.

Of true Alligators, one (*Alligator mississippiensis*, **31**, fig. 10) is North American and the other (*A. sinensis*, **32**) Chinese—a distribution explained by the occurrence of allied forms in the Tertiary deposits of Europe. The Chinese species alone has thin bony plates on the under surface. Both kinds inhabit swamps. The female of the North American Alligator constructs a large nest, in which the eggs are deposited in layers. Some species of Caiman, which may reach 20 feet in length, make regular migrations, retreating to the flooded forests in the wet season, and returning to the rivers during the dry months. In some districts they are called Jacares.

The Caimans (**25–27**) are peculiar in possessing a shield of bony plates in the skin of the under side of the body. On the under surface each plate consists of two distinct pieces, united by a transverse suture. In the species of which this armour is exhibited,

Fig. 9.



Side View of the Head of the Timsa or Nile Crocodile
(*Crocodilus niloticus*).
× Fourth lower tooth.
(Photographed from a specimen in the Museum.)

Fig. 10.

Side View of the Head of the N. American Alligator
(*Alligator mississippiensis*).
(Photographed from a specimen in the Museum.)

[*To face page* 10.

it is imperfectly developed, but in certain others the greater part of the tail is invested by complete bony rings—one to each vertebra—and the limbs are covered with small scutes of bone (**27** *a*).

One very fine specimen of the common Caiman, or Jacare-tinga (*Caiman sclerops*, **27**), is exhibited in a table-case.

The Gharial (*Gavialis gangeticus*, **5**), of the rivers of northern India and Aracan, and the False or Malay Gharial (*Tomistoma schlegeli*, **6**), of Malaysia, form a group of Crocodilians characterised by the length and narrowness of the muzzle, and the number and slenderness of the teeth. By most naturalists the group is included in the same family as the Crocodiles and Alligators (with which it agrees in the position of the inner aperture of the nostrils); but by others (who regard them as the direct descendants of the long-snouted Crocodilians of the Secondary period), Gharials are classed in a family by themselves. In addition to the length of the muzzle, Gharials are distinguished from Crocodiles and Alligators by the wide separation of the nasal bones from the aperture of the nostrils, and by the inclusion of the splenial bone in the long union (symphysis) between the two halves of the lower jaw. The true Gharial has from 27 to 29 pairs of lower teeth, none of the latter being received into pits in the upper jaw. The nasal bones are widely separated from the premaxillæ. In the False Gharial, on the other hand, the number of upper teeth is 20 or 21, and of lower teeth, 18 or 19; the tips of those on the sides of the lower jaw being received into pits in the upper jaw. The nasal bones are in contact with the premaxillæ. Gharials feed chiefly on fish, but large individuals of the Indian species will occasionally kill and devour human beings. In England the Gharial is frequently miscalled Gavial. Case 1.

The extinct *Phytosaurus* (or *Belodon*, **1**), of the Triassic formation of Europe, North America, and probably India, typifies a group of Crocodilians (the Parasuchia), which apparently indicates a primitive side-branch of this order. They are characterised by the bodies of the vertebræ having slightly cupped or nearly flat terminal articular surfaces; by the nostrils being situated far back on the skull, near the sockets of the eyes, and by the relatively forward position of the posterior openings of the nostrils, which are situated in front of the palatine bones. The armour consists of two rows of broad plates on the back, and several lateral rows of smaller ones. In the nearly allied *Stegranolepis*, of the Trias of Elgin, there is armour on both the upper and lower surfaces of the body. *Parasuchus*, from the Trias of India, is a third genus. Case 1.

Order IV.—RHYNCHOCEPHALIA—TUATERAS.

(Case 5.)

The New Zealand Tuatera (**47**) is the sole surviver of a Triassic and Permian group, which is the most generalised of all Reptiles. In the skull the quadrate-bone is fixed; there are two temporal arches, and teeth are present on the palate and the summits of the jaws, to which they are welded. The vertebræ have concave terminal faces, and intercentra are developed in the trunk, and chevron-bones in the tail. Each foot is five-toed; the lower end of the humerus is perforated on the inner side, and the abdomen is protected by a series of small bones.

The order is divided into :—

I. RHYNCHOCEPHALIA VERA, in which the abdominal bones are closely packed, with three elements in each transverse series, and there are two sacral vertebræ, the intercentra being sometimes suppressed.

II. PROTOROSAURIA, in which each series of abdominal bones consists of a number of elements, and the intercentra are fully developed. This group passes into the Microsauria, among the Stegocephalan Amphibia, in which the body is armoured, the vertebræ are completely ossified, and the ribs retain two heads.

Case 5. The Tuatera itself (*Sphenodon punctatus*, **47**, fig. 11) is a burrowing lizard-like reptile, now confined to a few small islands off the New Zealand coast, having been exterminated from the mainland by pigs. These Reptiles share their burrows with birds—shear-waters, or petrels. They feed entirely upon small living animals, and deposit their eggs in a chamber, forming one side of the extremity of the burrow, the shear-water occupying the opposite side.

Casts of skulls of the extinct *Rhynchosaurus* (**50**) from the Trias of Shropshire, and of *Hyperodapedon* (**49**) from the same formation in both England and India, are exhibited in the case. Both were near allies of the Tuatera, but in *Hyperodapedon* the teeth formed a kind of pavement on the palate. Casts of the skeletons of *Sapheosaurus* (**46**), from the Oolite of Bavaria, an allied type, and of *Protorosaurus lincki* (**48**) are shown.

FIG. 11.

THE TUATERA LIZARD (*Sphenodon punctatus*). New Zealand.
(From a specimen in the Museum.)

[To face page 12.

Order V.—PELYCOSAURIA (*extinct*).
(Case 5.)

Although at one time classed with the Theromorpha, the extinct Permian Pelycosauria are now regarded as a distinct group, more nearly allied to the Rhynchocephala, which they resemble in possessing two temporal arches to the skull. The dentition generally approximates to that of the Theriodont Theromorphs. Well-known genera are *Clepsydrops*, *Dimetrodon*, *Embolophorus*, and *Naosaurus*; the three latter being characterised by the tall upright spines of the trunk-vertebræ, which in some cases were equal in length to the entire skeleton, and during life probably supported a fin-like expansion of skin, as shown in the coloured sketch (**48***a*) exhibited in the case.

Order VI.—SQUAMATA.

Snakes and Lizards.
(Cases 11–15 and 18–20.)

Snakes and Lizards form at the present day the most numerous representatives of the reptilian class. They are characterised by the circumstance that the quadrate-bone (which forms the articulation of the lower jaw) is more or less movably attached to the skull, as well as by the presence of only one lateral bar (temporal arch) in the latter, and by the teeth being welded to the jaws. The body is usually covered with horny scales; and the aperture of the vent is transverse.

The existing members of the group are divided into three sub-orders:—

I. Ophidia, or Snakes. Characterised by the fibrous union of the right and left halves of the lower jaw, or mandible, the absence of functional limbs, of which (at most) only minute vestiges remain, and the elongated form of the body. The single eye-lid cannot be moved, and is transparent. Cases 11–15.

II. Lacertilia, or Lizards. In this group the right and left halves of the lower jaw are connected by a bony union. The great majority possess functional limbs, movable eyelids, and horny scales; but a considerable number have a more or less completely snake-like form, with the reduction or loss of one or both pairs of limbs; and in some cases the eye-lids Cases 18–20.

are transparent and fixed as in Snakes, while the scales may be rudimentary or wanting. In some of the limbless burrowing forms the quadrate-bone has become more or less fixed.

Case 20. III. RHIPTOGLOSSA, or CHAMÆLEONS. These differ from Lizards in several particulars; notably the separation of the toes into two groups of three and two respectively, so that the feet form most efficient grasping organs, and the long extensile, club-shaped tongue. The skeleton lacks clavicles and interclavicle; and there are several osteological peculiarities in the skull, which is casque-shaped and often studded with tubercles.

In addition to the above, there are the two following extinct sub-orders, the members of which were marine.

Shown in Geological Department. IV. DOLICHOSAURIA. Includes several snake-like forms typified by *Dolichosaurus* of the English Chalk, which was over a yard in length, with the two halves of the lower jaw united by a bony suture, two sacral vertebræ, a long neck, and the limbs partially modified into paddles.

V. PYTHONOMORPHA. Typified by the gigantic ***Mosasaurus*** of the Upper Cretaceous, and characterised by the ligamentous union of the right and left halves of the lower jaw, the presence of only one sacral vertebra (with which the pelvis has no connection), and the completely paddle-like form of the limbs.

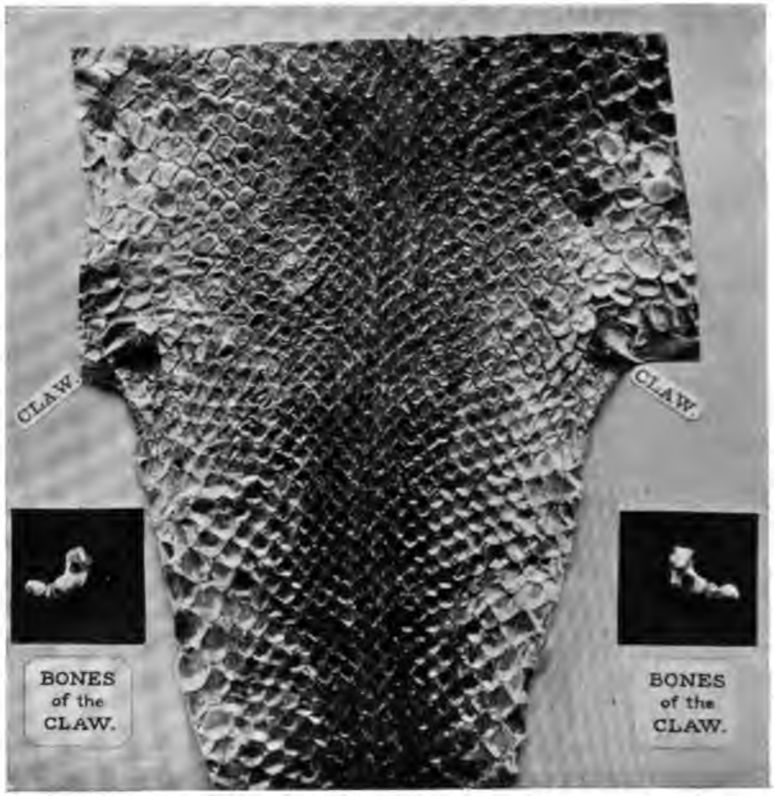
The following are the sub-divisions of the

Order SQUAMATA.*

a. Sub-order OPHIDIA.	*b*. Sub-order LACERTILIA.
Family *Boidæ*.	Family *Geckonidæ*.
„ *Typhlopidæ*.	„ *Eublepharidæ*.
„ *Glauconiidæ*.	„ *Uroplatidæ*.
„ *Ilysiidæ*.	„ *Pygopodidæ*.
„ *Uropeltidæ*.	„ *Agamidæ*.
„ *Xenopeltidæ*.	„ *Iguanidæ*.
„ *Colubridæ*.	„ *Xenosauridæ*.
„ *Amblycephalidæ*.	„ *Zonuridæ*.
„ *Viperidæ*.	„ *Anguidæ*.

* In consequence of the Cases not being all of a uniform depth, it has been found impossible to adhere strictly to this arrangement of the families.

Fig. 12.



A.—Part of the flattened skin of an African Python (*Python sebæ*). Showing Claws representing Hind-Limbs, together with their supporting bones.

B.—Complete Bones of the Hinder Limb-Girdle of another Specimen.

Rudimentary Limbs of Pythons.

[*To face page* 15.

Order SQUAMATA—*continued.*

b. Sub-order LACERTILIA (*continued*).
Family *Anniellidæ.*
„ *Helodermatidæ.*
„ *Varanidæ.*
„ *Xantusiidæ.*
„ *Teiidæ.*
„ *Amphisbænidæ.*
„ *Lacertidæ.*
„ *Gerrhosauridæ.*
„ *Scincidæ.*

b. Sub-order LACERTILIA (*continued.*)
Family *Anelytropidæ.*
„ *Dibamidæ.*

c. Sub-order RHIPTOGLOSSA.
Family *Chamæleontidæ.*

d. Sub-order PYTHONOMORPHA. (Extinct.)
Family *Dolichosauridæ.*
„ *Mosasauridæ.*

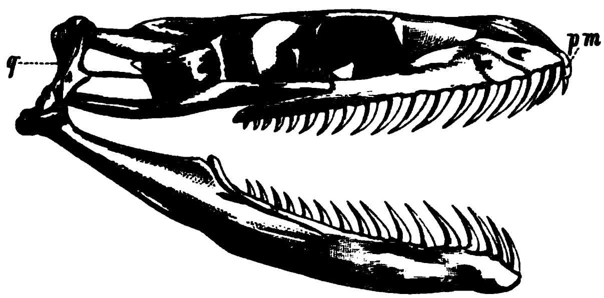
Sub-order I.—OPHIDIA—SNAKES.

(Cases 11–15.)

As the distinctive characteristics of this group have been already given under the heading of the order Squamata, we may at once pass to a brief survey of the more important families. Case 14.

The first family is that of the *Boidæ*, or Boas and Pythons, among which are included the largest of living Snakes. The skeleton retains vestiges of the pelvis and hind-limbs, and the latter are represented externally by small claw-like spurs near the vent (fig. 12). On the upper surface the scales are usually small and smooth, but those on the lower aspect form ~~two~~ broad series in advance of the tail, and either a double or single row on the tail itself. In the one

Fig. 13.



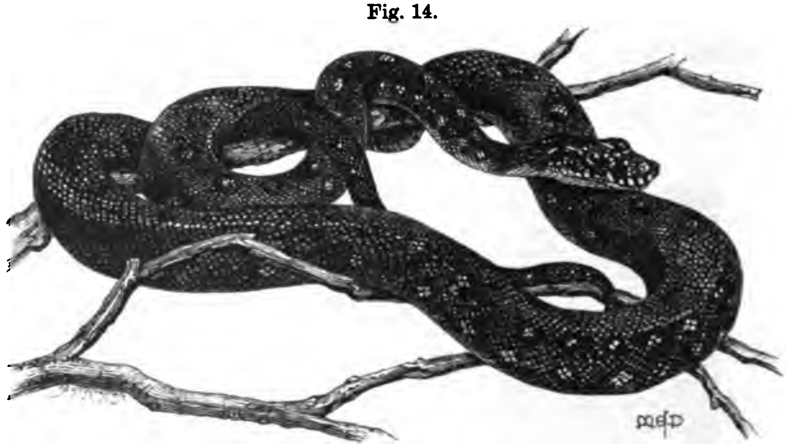
Skull of a Python; ½ nat. size. (No. 291.)

m, maxillary; *pm*, premaxillary; *q*, quadrate-bone.

skull the quadrate-bone is supported by the horizontally extended squamosal, which rests loosely on the side of the occipital region. Teeth are carried in the lower jaw, and on the pterygoid, palatine, and maxillary bones of the skull; while in some of the Pythons (*Pythoninæ*), as distinct from the Boas (*Boinæ*), they are also borne on the premaxillæ. In the Boas there is a pair of supra-orbital bones, which are wanting in the Pythons, and the scales on the under side of the tail generally form a single (instead of a double) row. None of the members of this family are poisonous. The larger kinds inhabit forests, where they climb trees by the aid of the short and partially prehensile tail. They feed by choice on warm-blooded animals, the bodies of which they crush in their coils before swallowing them. Although a large Python could crush an animal as large as a red deer, it is quite evident that it could not swallow the carcase. The bodies of small deer are reduced by crushing to the condition of a sausage before being swallowed. Most Pythons lay masses of eggs, which the female protects by coiling herself upon them.

Two magnificent specimens of the Malay Python (*Python reticulatus*, **291**) are exhibited, one measuring 24 feet 11 inches in length. Among the smaller species, mention may be made of the Australian Carpet-Snake, or Diamond-snake (*P. spilotes*, **288**, fig. 14).

Fig. 14.



Australian Carpet-Snake (*Python spilotes*). (No. **288**.)

The *Boa constrictor* (**300**) is an example of a genus common to Tropical America and Madagascar. Specimens of part of the skin

of a Python (**287**) and a Boa Constrictor (**300**) are exhibited to display the claw-like vestiges of the hind limbs and the rudimentary supporting bones (fig. 12). Eggs of *Python sebæ* (**287**) are also exhibited.

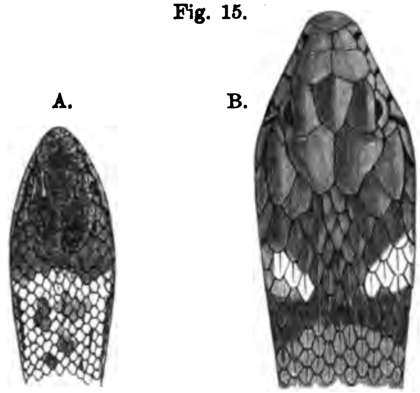
The huge Anaconda (*Eunectes murinus*, **281**) differs from the members of the genus *Boa* chiefly by the circumstances that the innermost of the three nasal shields of the head is in contact with its fellow, and likewise by the absence of small scales between the labial shields and the eye. Moreover, the muzzle is covered with large shields instead of small scales. During life the pupil of the eye is vertical. Anacondas are both arboreal and aquatic, and thus admirably suited to a life in the flooded forests of tropical America. Their food consists chiefly of mammals and birds, which are captured (mainly at night) both on land and in the water. Specimens are stated to attain a length of over 30 feet; but the one exhibited is only about 18¾ feet. These Snakes produce their young alive. **Table-case.**

We next come to the Burrowing Snakes, constituting the families *Typhlopidæ*, *Glauconiidæ*, *Uropeltidæ*, and *Ilysiidæ*, which are small Snakes of more or less completely burrowing habits, in all but the third of which traces of the pelvis remain. In the *Typhlopidæ* (**303**, **304**) the eyes are vestigial, there are no teeth in the lower jaw, and the body is uniformly covered with small scales. They are entirely burrowing and insectivorous; and may be regarded as survivors of a generalised group connecting Snakes with Lizards. Most of the species belong to *Typhlops* (**303**, **304**). The *Glauconiidæ* differ chiefly by having teeth only in the lower jaw; the pelvis and hind-limbs are less aborted than in any other Snakes. In the Shield-tails, or *Uropeltidæ* (**297–299**), which take their name from the large shield terminating the tail, the eyes are very small, the head is not distinct, and the scales on the lower surface of the body are but little enlarged. The *Ilysiidæ* (**296**) differ by the eyes being generally free, although sometimes covered with scales. There are vestiges of the pelvis and hind-limbs, the latter visible externally as spur-like claws by the vent. Teeth (as in the *Uropeltidæ*) are present in both jaws, but the short tail does not terminate in a shield. Of the few species, *Cylindrophis rufus* (**296**), is exhibited, while one of the best known is the Coral-Snake (*Ilysia scytalis*) of tropical South America. All the members of this family feed on worms, insects, and small *Typhlopidæ*, and produce living young. The more completely burrowing species of this group are not unlike large worms in appearance and habits, for which, indeed, they are not infrequently mistaken. **Case 14.**

Cases 11, 12, and 15.

With the family *Colubridæ* we reach the typical Snakes, which comprise some nine-tenths of the Ophidia, and may be roughly defined as normal Snakes which are neither Pythons (*Boidæ*) nor Vipers (*Viperidæ*). In other words, they are Snakes with well-developed eyes, without vestige of hind-limbs, and with normal upper jaws, usually carrying numerous teeth. The following are some of the chief characteristics of the family: A median longitudinal groove divides the shields on the chin; the squamosal bone of the skull is horizontally elongated and movable; and the pterygoid

Fig. 15.



Heads of the Smooth Snake (*Coronella austriaca*), A (No. **261**), and the Common Snake (*Tropidonotus natrix*), B (No. **240**).

Fig. 16.

Head of the Viper (*Vipera berus*). (No. **318**.)

Heads of the three British Snakes.

bone reaches the quadrate. The family is divided into three series and eight sub-families, as follows:—

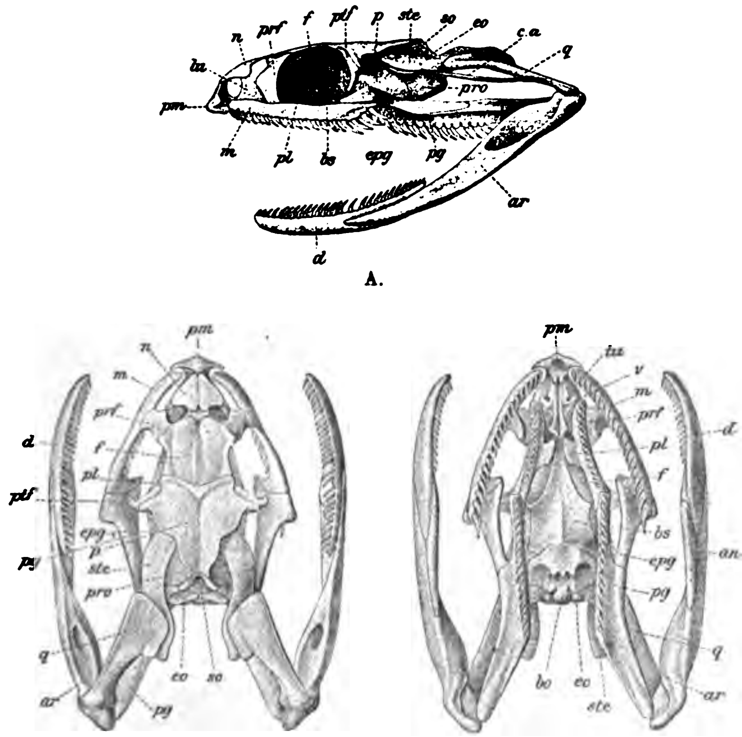
A. Aglypha. The teeth solid and ungrooved.
- Sub-family 1. *Acrochordinæ*.
- „ 2. *Colubrinæ*. Common Snake, Rat-Snake, etc.
- „ 3. *Dasypeltinæ*. African Egg-eating Snake.

B. Opisthoglypha. One or more of the hinder teeth in the upper jaw grooved.
- Sub-family 4. *Dipsadomorphinæ*. Indian Tree-Snakes.
- „ 5. *Elachistodontinæ*. Indian Egg-eating Snake.
- „ 6. *Homalopsinæ*. Oriental Water-Snakes.

C. Proteroglypha. The front upper teeth grooved or perforated.
- Sub-family 7. *Elapinæ*. Cobras and Kraits.
- „ 8. *Hydrophiinæ*. Sea-Snakes.

The majority of the members of series *A*. are harmless, but the saliva of the Indian Rat-Snake affects small mammals; most of series *B*. are venomous, but not dangerously so; but all the species

Fig. 17.



B. C.

Skull of the Common Snake (*Tropidonotus natrix*). (No. **240**.)
From the left side (A), above (B), and below (C).

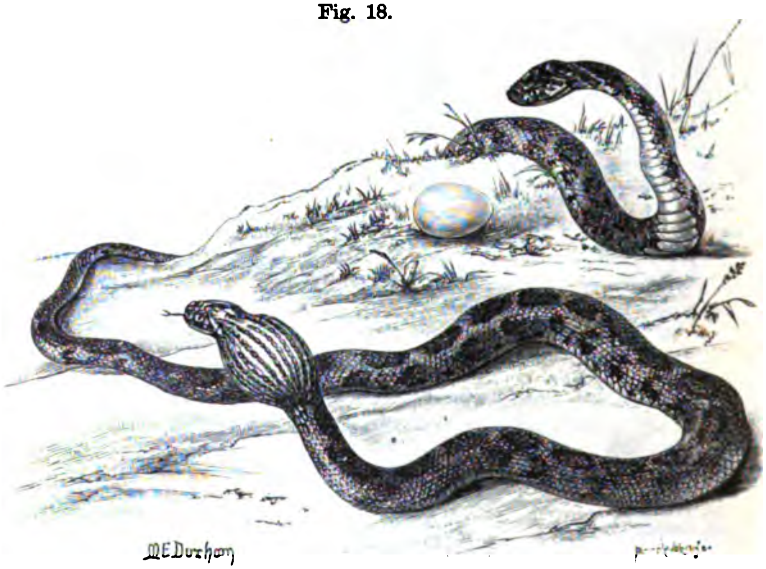
an. Angular.
ar. Articular.
bo. Basioccipital.
bs. Basisphenoid.
ca. Columella auris.
d. Dentary.
eo. Exoccipital.
epg. Ectopterygoid.
f. Frontal.
m. Maxillary.
n. Nasal.
p. Parietal.
pl. Palatine.
pm. Præmaxillary.
prf. Præfrontal.
pro. Prootic.
pg. Pterygoid.
ptf. Postfrontal.
q. Quadrate.
so. Supraoccipital.
ste. Supratemporal.
v. Vomer.

included in *C*. are deadly. Among the more noticeable specimens belonging to the first group, reference may be made to the common British Snake (*Tropidonotus natrix*, **240**) and a continental variety

(**241**) of this species distinguished by the absence of black patches at the back of the head. The other harmless British species is the Smooth Snake (*Coronella austriaca*, **261**), found in England only in the south, and there but seldom. Both these Snakes have large, shield-like scales on the top of the head, and thereby differ from the Viper, as shown in the accompanying cuts. Other well-known Snakes of the group are the North American Water-Mocassin (*Tropidonotus fasciatus*, **242**), the Indian Rat-Snake (*Zamenis mucosus*) and the American Black Snake (*Z. constrictor*, **250**), and, belonging to another genus, the European Four-lined Snake (*Coluber quatuor-lineatus*, **253**), the North American Bull-Snake (*C. melanoleucus*), and the South American Bushmaster (*C. corais*, **255**). The Australian *Dendrophis punctulatus* (**257**) is a good example of the Tree-Snakes, while the Small-scaled Snake (*Coronella micropholis*, **262**), with its alternate bands of black and scarlet, displays a type of colouring very uncommon among Serpents.

An extremely interesting Snake in this family is the African

Fig. 18.



African Egg-eating Snake (*Dasypeltis scabra*); ½ nat. size. (No. **272**.)

Egg-eating Snake (*Dasypeltis scabra*, **272**, fig. 18), which typifies a sub-family (*Dasypeltinæ*) by itself. Its greatest peculiarity is that the

lower spines of the neck-vertebræ pierce the gullet, on the upper surface of which they form tooth-like knobs adapted for crushing the eggs on which this Snake feeds. An individual of a foot in length is capable of swallowing a pigeon's egg.

Sea-Snakes (*Hydrophiinæ*, **308–313**) and the Cobra group (*Elapinæ*) form the assemblage of venomous *Colubridæ* known as Proteroglypha (see p. 18), and characterised by the grooving of the front teeth in the maxillary bone, while those behind are solid. In this respect they differ from the Opisthoglypha, in which the reverse condition obtains. Sea-Snakes (fig. 19), of which there are several genera, have the tail, and sometimes the body, compressed, for the purpose of swimming. The scales are small, those on the lower surface being often no larger than the rest; and the pupils of the small eyes are round. These Snakes inhabit tropical seas from the Persian Gulf to Central America, but one species (*Distira semperi*) dwells in a fresh-water lake in the Philippines. They are often seen far out at sea, and die if kept long on land. All are viviparous, and feed on fishes, which are killed with their poison. Indian fishermen are occasionally bitten by these Snakes, the bite sometimes proving fatal. The largest species is the orange and black *Hydrus major* (**308**), of which an example is shown. Most of these snakes are coloured very like mackerel in order to render them invisible in the sea. **Cases 14–15.**

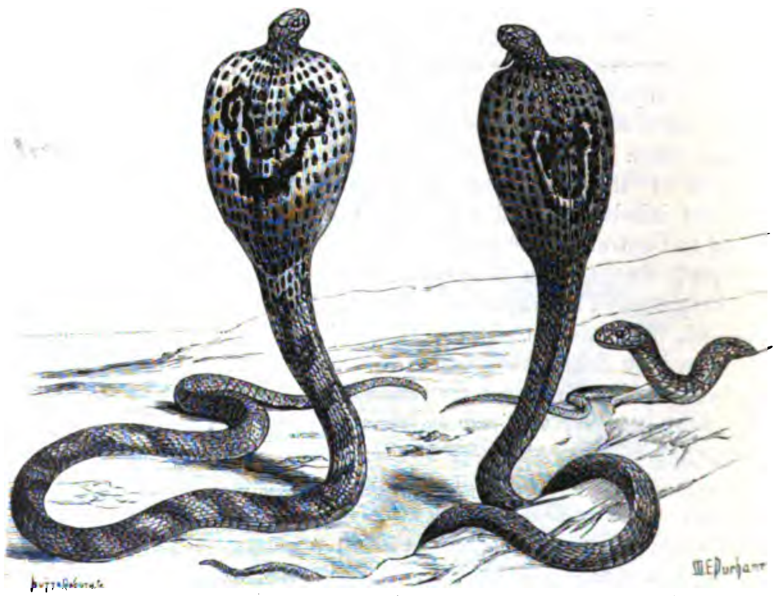
Fig. 19.

A Sea-Snake (*Hydrophisplaturus*) from the Indian Ocean. (No. **312**.)

The Cobras and Kraits of the Old World, together with the species of the American genus *Elaps*, represent the *Elapinæ*, or second sub-family of the group Proteroglypha, which is distinguished from the *Hydrophiinæ* by the cylindrical tail. There are numerous genera of *Elapinæ*; and the sub-family includes the majority of Australian Snakes and all the venomous ones. The various species of Cobras (an abbreviation of *cobra di capello*—"the snake with the hood") are characterised by the power of inflating the neck into a hood-like expansion by an outward and forward movement of the

ribs. These Snakes are exceeding deadly. Well-known species are the Indian Cobra (*Naia tripudians*, **276**), the African Cobra, or "Asp" (*N. haie*, **277**), and the Giant or King Cobra (*N. bungarus*, **274**). The Ringhals ("banded neck"), *Sepedon hæmachates*, is another South African hooded Snake. The Kraits differ by the lack of the hood; the true Krait (*Bungarus cæruleus*) causes more deaths in India than any other Snake, but the Banded Krait (*B. fasciatus*, **273**), although larger, reaching five feet in length, does less mischief. The Death-Adder (*Acanthophis antarcticus*), easily

Fig. 20.



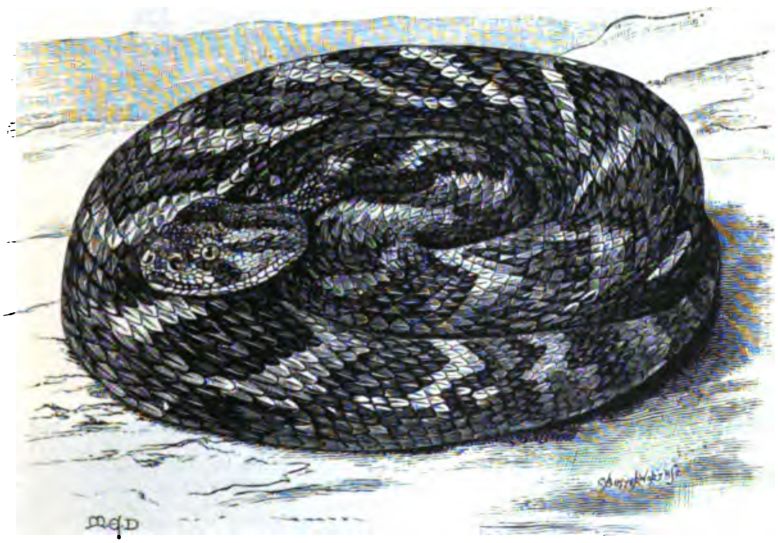
The Indian Cobra (*Naia tripudians*); ⅓ nat. size. (No. **276**.)

recognised by the spines to its tail, is one of the most deadly of Australian Snakes. The South American *Elaps corallinus* is conspicuous for its alternating bands of black and scarlet, separated by narrow rings of yellow.

In this group are exhibited the ordinary and the black phases of the Indian Cobra (*Naia tripudians*, **276**, fig. 20), the great Indian King Cobra, or Hamadryad (*N. bungarus*, **274**), and the African Ringed Cobra (*N. haie annulifera*, **277**). Of the still more venomous and deadly Indian Kraits, the yellow and black banded species (*Bungarus fasciatus*, **273**) is shown.

It is a common notion that Vipers, Rattle-Snakes, and their like (family *Viperidæ*) are the only poisonous Snakes. This is a mistake, the Cobra, which is one of the most deadly Snakes, not being a member of the Viper family. It is, however, a fact that all the representatives of that group are deadly. The Vipers and their kindred may be distinguished by the following features. In the fore part of the mouth is a pair of poison-fangs, supported by the short and otherwise toothless maxillary bones, which are capable of being vertically erected; the scales on the under surface of the body

Fig. 21.



The Puff-Adder (*Bitis arietans*); ½ nat. size. (No. **315**.)

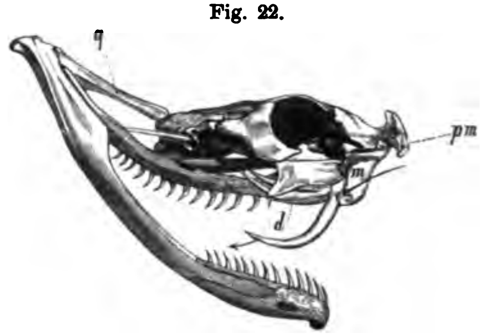
are transversely elongated; and the eyes are well developed. The poison-fangs are tubular, having a broad hole at the front of the base in connection with the poison-gland. Successional teeth are developed behind the fangs in use, and take the place of the latter when they are broken off or worn out. All the species are viviparous as well as poisonous. The family is divided into two groups—True Vipers and Pit-Vipers.

The True Vipers (*Viperidæ*) are confined to the Old World and have no pit between the eye and the nose. Among familiar forms may be mentioned the Common Viper, or Adder (*Vipera berus*, **318**,

fig. 16), the Indian Russell's Viper (*V. russelli*, **320**), and the African Puff-Adder (*Bitis arietans*, **315**), Gaboon Puff-Adder or Viper (*B. gabonica*, **317**), and Horned Puff-Adder (*B. nasicornis*, **316**). All these African Vipers are brilliantly coloured, but the Horned Viper (*Cerastes cornutus*) of North Africa is coloured to correspond with the desert-sand.

The Pit-Vipers (*Crotalinæ*) take their name from the presence of a pit, which probably subserves some sense-function, between the eye and nose. The typical American forms (*Crotalus*) are called Rattle-snakes from the presence of a number of loose horny rings at the end of the tail. Other kinds are the Water-Viper (*Ancistrodon piscivorus*, **330**) and the Copper-head (*A. contortrix*, **329**) of North America, the South American and West Indian Fer-de-lance (*Lachesis*

Fig. 22.



Skull of Horned Puff-Adder (*Bitis nasicornis*), a venomous Serpent. (No. **316**.)

m, maxillary, with poison-fang; a bristle is inserted in the openings of the channel at the base and point of the tooth; *d*, undeveloped poison-fangs; *pm*, premaxillary; *q*, quadrate bone.

From a specimen in the Museum.

lanceolatus, **326** A), the Indian Green Viper (*L. gramineus*), the green Wagler's Viper (*Lachesis wagleri*, **327**) of Malaysia, which lives in trees, and the great black and orange Curucucu (*L. mutus*, **328**) of Surinam.

The American Rattle-Snakes (*Crotalus* and *Sistrurus*), as already mentioned, have at the end of the tail a rattle composed of a number of horny rings or bell-like structures which fit into one another. The oldest, or terminal, bell is really the horny sheath of the tail-tip; and with each casting of the skin the youngest bell becomes loose, but is held in place by the new covering. An ever-increasing number of loosely-attached bells is thus produced; but

occasionally most of the bells (perhaps when worn out) drop off, and a new set is developed. Rattles with a dozen or more bells are very rare, especially at the present day. No indication of a Snake's age can be drawn from the number of bells in the rattle. Most Rattle-Snakes have numerous small scales on the head and are included in *Crotalus*, but in one species, constituting the genus *Sistrurus*, there are nine large shields on the top of the head.

Specimens of the ordinary North American Rattle-Snake (*Crotalus horridus*, **325**) and of a much larger South American species (*C. confluentus*, **323**) are exhibited.

Sub-order II.—Lacertilia.—Lizards.
(Cases 18–20.)

The first representatives of the sub-order Lacertilia (of which the characteristics will be found on page 13) are the Geckos, constituting the families *Geckonidæ*, *Eublepharidæ*, and *Uroplatidæ*. These reptiles take their name from the cry, "Geck-ko," of the common Turkish species. The members of the typical family are four-footed lizards, without movable eyelids, and with a broad fleshy Case 18.

Fig. 23.

Head of Indian Gecko (*Gecko verticillatus*), to show form of eye.

Fig. 24.

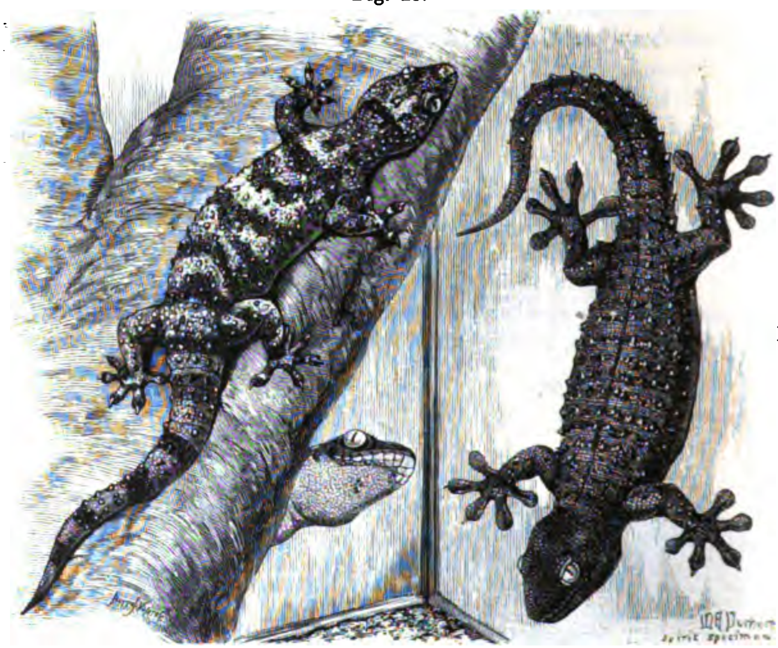
Hind-leg of Indian Gecko, from the lower surface, to show the adhesive pads formed by parallel transverse plates.

tongue, slightly notched at the tip, and capable of being protruded from the lips. The dentition is of the pleurodont type, that is to say, the teeth are attached to the inner side of the outer parapet of

the margin of the jaws. In the skeleton the bodies of the vertebræ are cupped at both ends (amphicœlous); the clavicles (collar-bones) are dilated and perforated near their junction with the breast-bone; and the parietal bones of the skull are separate. In the second family the vertebræ articulate by ball-and-socket joints, the eyes have movable eyelids, and the parietals are united. The members of the third family show no expansion of the clavicles.

Fig. 25.

A



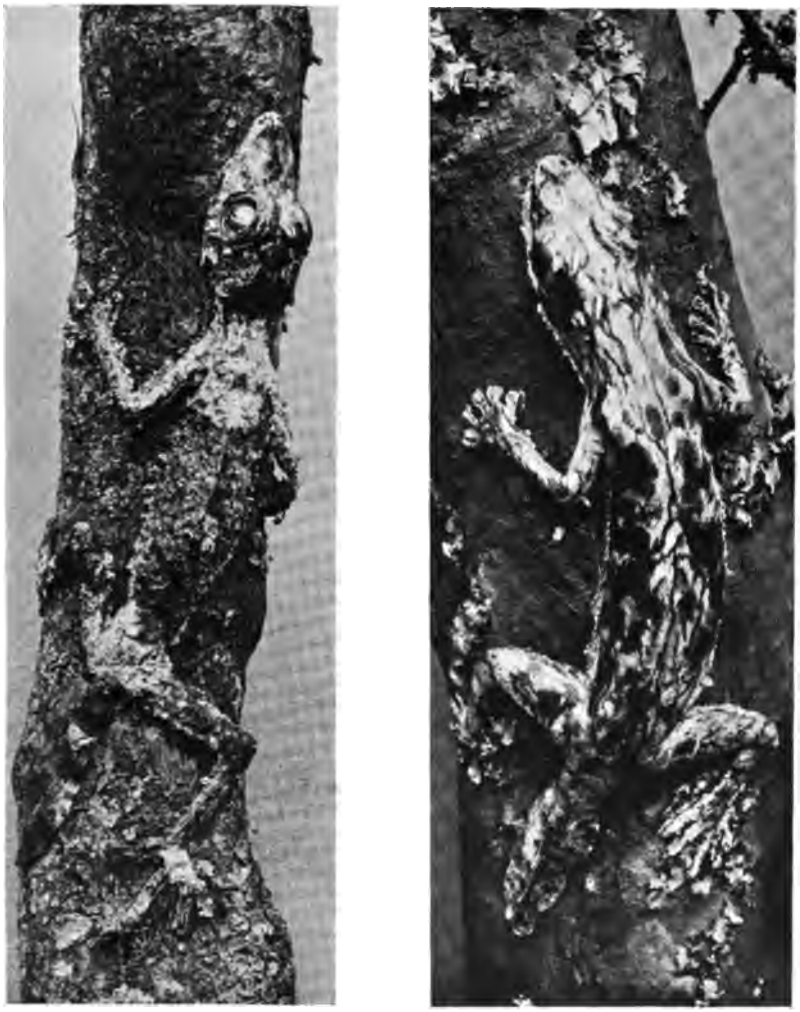
B

A, Turkish Gecko (*Hemidactylus turcicus*), and B, Common Gecko (*Tarentola mauritanica*).

The tail varies, being in some cases of ordinary form, and in others trowel-shaped. Many species have the toes expanded and furnished with adhesive structures, by means of which they are able to climb window-panes and adhere to ceilings (fig. 24). The eggs, which are nearly spherical and usually two in number, have hard shells. Geckos feed on animal matter, chiefly insects, and are quite harmless, and for the most part nocturnal. In a limited degree they have the power of changing colour according to the nature of their surroundings.

FIG. 26.

A. B.



MALAGASY BARK-GECKOS.

A.—THE LICHEN BARK-GECKO (*Uroplates fimbriatus licheni*).

B.—THE COMMON BARK-GECKO (*Uroplates fimbriatus*).

(From specimens in the Museum.)

[*To face page 26.*

One of the most remarkable instances of protective resemblance in this group is afforded by the Lichen Bark-Gecko (*Uroplates fimbriatus licheni*, **355**, fig. 26 *a*), which clings to the bark of lichen-

Fig. 27.

A Flying Lizard, or "Flying Dragon" (*Draco tæniopterus*). (Compare No. **366**.)

clad trees. The close resemblance presented by the Lizard to the bark is well exhibited by the specimen in the case. Other species shown include the Common Gecko (*Tarentola mauritanica*, **355**, fig. 25 *b*), the Fringed Gecko (*Ptychozoon homocephalum*, **359**) of the

Malay countries, and the curious Short-tailed Gecko (*Nephurus lævis*, **357**) of Australia.

Case 18. A small number of snake-like Lizards constitute the family *Pygopodidæ*, of which *Pygopus lepidopus* (**388**) and *Lialis burtoni* (**385**) are the best-known. Examples of each are shown in the case. These Scale-footed Lizards, as they may be called, are quite destitute of fore-limbs, and the hind-limbs are reduced to a pair of scale-like flaps. The teeth are of the pleurodont type, the eyes are devoid of

Fig. 28.

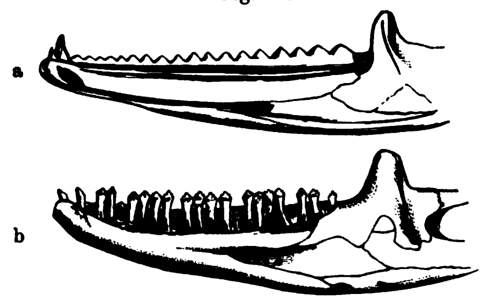
Spine-tailed Lizards (*Uromastix acanthurus*); ½ nat. size. (Compare No. **377**.)

movable eyelids and have the pupil vertical, and the tongue is cleft and extensile. The long tail is very brittle.

Case 18. The family group *Agamidæ*, typified by the Stellion Lizard (*Agama stellio*, **370**) of southern Europe, comprises a large assemblage of Lizards differing from nearly all others in that their dentition is of the acrodont type, that is to say, the teeth are attached to the summits of the jaws (fig. 29 *a*). Other features are the broad and short tongue, and the absence of bony plates or nodules in the skin; but spines, especially on the head and tail, are often present. There

are about 200 species, arranged in some 30 genera, all confined to the Old World. The majority have depressed bodies and are terrestrial; but some, in which the body is compressed, are arboreal.

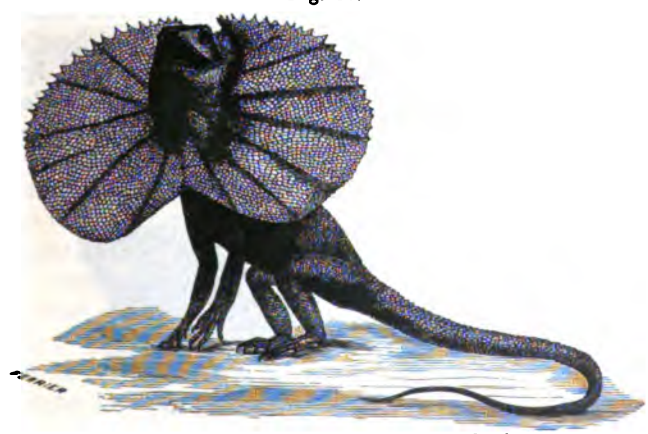
Fig. 29.



Right half of the Lower Jaw of a Stellion Lizard (a), to exhibit the acrodont dentition, and of an Iguana (b), to show the pleurodont type of dentition.

Most of the species are insectivorous, but certain kinds of *Agama* have a mixed diet, and *Uromastix* (**377**, fig. 28) and some of its allies feed entirely on fruits and herbs. In the Flying-Dragons

Fig. 30.



Australian Frilled Lizard (*Chlamydosaurus kingi*), with the frill expanded in the "terrifying" attitude. (No. **379**.)

(*Draco*, **366**, fig. 27) the sides of the depressed body carry wing-like membranes supported by expansions of the ribs, by means of which these reptiles pass from bough to bough, although they are incapable

of true flight, like that of a bird. The Frilled Australian Lizard, *Chlamydosaurus kingi* (**379**), which can run on its hind-legs in a semi-upright posture, has an expansible frill round the neck (fig. 30).

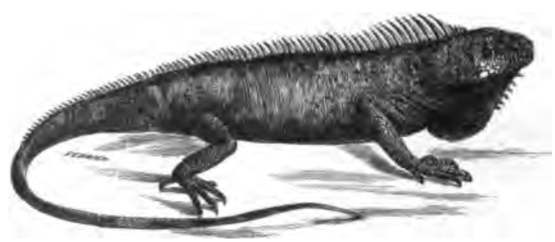
Fig. 31.

Australian Moloch Lizard (*Moloch horridus*). (No. **372**.)

In the Indian and African *Uromastix* (**377**, fig. 28) the tail is spiny, and in the Australian *Moloch* (**372**, fig. 31) the whole head and body are covered with spines of different sizes, the body being remarkably depressed and expanded.

Case 18. The Iguanas, family *Iguanidæ* (**381–403**), are the New World representatives of the *Agamidæ*, from which they differ by the pleurodont dentition, that is to say, by the teeth being attached to the inner side of the external parapet of the jaws (fig. 29 *b*). Although large Lizards from other parts of the world are often miscalled Iguanas, the family is chiefly American, with representatives in Madagascar and Fiji. There are some 300 species, arranged in about 50 genera,

Fig. 32.



Tuberculated Iguana (*Iguana tuberculata*). (No. **381**.)

which display considerable variation in form and habits. Some are arboreal, others terrestrial or burrowing, and others semi-aquatic, one of the latter resorting to the sea. Many of the species are

herbivorous, but others subsist on insects. Of the true Iguanas, such as *Iguana tuberculata* (**381**, fig. 32), the flesh is often eaten; the species grows to between 5 and 6 feet. *Polychrus* (**402**) has the chamæleon-like power of changing its colour. Many species, notably the partially aquatic *Basaliscus* (**387**), have spines or fin-like expansions running down the middle line of the back; and in the so-called Californian Toad (*Phrynosoma cornutum*, **396**, fig. 33) and its relatives the whole body is spiny. The last-named Lizards have the peculiar power of squirting jets of a red fluid supposed to be blood from their eyes. In their depressed form and spine-clad skin, these Lizards present a curious parallelism to the Moloch Lizard in the *Agamidæ*. It will be noticed that in the more typical Iguanas,

Fig. 33.

Spiny Iguana, or Californian Toad (*Phrynosoma cornutum*). (No. **396**.)

which are arboreal in their habits, the body and tail are much compressed, and the prevailing colour is green, to harmonise with the foliage among which these reptiles dwell. The Sea-Iguana (*Amblyrhynchus cristatus*, **389**), of the Galapagos Islands, spends much of its time in the sea, and feeds on sea-weed. It is represented on land by the nearly allied *Conolophus subcristatus* (**403**). Examples of other genera, such as the Fijian *Brachylophus* (**398**) and the short-tailed *Hoplocercus* (**401**) of Brazil, are also shown.

The two families *Zonuridæ* (**426–428**) and *Xenosauridæ* serve to connect the *Iguanidæ* with the *Anguidæ*. In both the dentition is pleurodont, but the teeth are solid only in the *Xenosauridæ*. In that family the anterior part of the tongue is retractile (as in the *Anguidæ*), and bony nodules are developed in the skin of the body. On the other hand, the *Zonuridæ* have short non-retractile tongues like those of the *Iguanidæ*, but bony nodules are developed at least in the skin of the head, where they roof over the temporal region. The second family is represented only by a single species from South Case 20.

Mexico; but the first has about 12 species, grouped in 4 genera, and ranging over South and Tropical Africa. In the typical genus *Zonurus* (**426–427**), the whole of the body and tail is encased in bony plates, the horny coverings of which form sharp spines, especially on the tail. These Lizards inhabit desert districts. Specimens of several species are exhibited in the case.

Case 20. The group of Lizards (family *Anguidæ*) typified by the English "Slow-Worm" has a pleurodont dentition, with the teeth solid. The tongue consists of two portions, of which the front half is notched and capable of being withdrawn into the basal half. Bony plates are developed in the skin of the body and head, and roof over the temporal region of the skull. There is a marked tendency

Fig. 34.

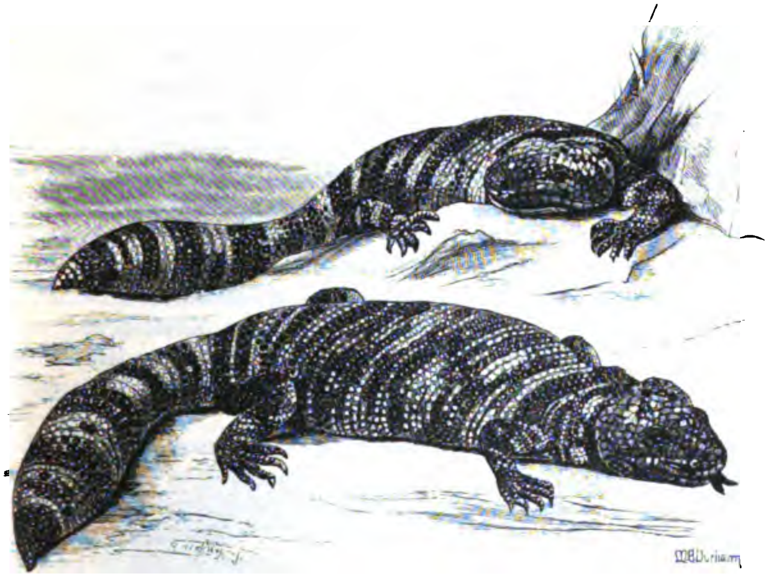
The Slow-Worm (*Anguis fragilis*); ½ nat. size. (No. **429**.)

throughout the family to a reduction of the limbs, culminating in their complete loss in the Slow-Worm. Traces of the shoulder and pelvic girdles always persist. The long, brittle tail is readily replaced. All the species (40 or so in number, and arranged in seven genera) are terrestrial and feed on animal substances; and some at least, like the Slow-Worm, produce living young. In the American genus *Gerrhonotus* there is a pair of folds running along the sides of the body, and the limbs are well developed. Similar folds occur in the Glass-Snakes (*Ophisaurus*, **431**), but the limbs are represented only by a pair of flaps in the neighbourhood of the vent. In the Slow-Worm (*Anguis fragilis*, **429**, fig. 34) no external trace of the fold or limbs remains; the notion that the creature is venomous

is entirely erroneous. Fine specimens of the South European Scheltopusik, or Glass-Snake (*Ophisaurus apus*, **431**) are exhibited.

The so-called Gila Monster (*Heloderma suspectum*, **424**, fig. 35) of Mexico and an allied species from New Mexico and Arizona, alone constitute a family (the *Helodermatidæ*, or Poisonous Lizards) characterised by the presence of recurved fang-like teeth loosely attached to the lower jaw, which discharge poison through open grooves secreted by special glands. The dentition is pleurodont, the tongue is cleft at Case 19.

Fig. 35.



The Gila Monster (*Heloderma suspectum*); ⅛ nat. size. (No. **424**.)

the tip, and the bony plates in the skin are small, and communicate the peculiar granular texture to the upper surface. The Gila Monster is a creature of lethargic and nocturnal habits, crawling about in the evening in search of worms, frogs, centipedes, and Iguanas' eggs. Frogs are paralysed, if not killed, by the bite, which is also dangerous to human beings, although rarely productive of death. In captivity these Lizards eagerly break eggs and lap up the contents. During the hot season they become torpid.

A very rare Bornean Lizard (*Lanthanonotus borneensis*) is nearly allied to the *Helodermatidæ*, from which it is distinguished by the

absence of grooved teeth (and therefore probably of poison-glands) and of bony granules in the skin.

Case 19. The members of the family *Varanidæ* (**407–420**), which include the largest of all Lacertilia, derive their common name of "Monitors," or "Warning Lizards," from a confusion between "Ouaran," the Arabic designation of a Lizard, and the English word "warning." Agreeing with many other members of the sub-order in having the teeth attached to the inner side of the outer parapet of the jaws (pleurodont type), Monitors are specially characterised by the long. smooth, and forked tongue, which can be protruded and withdrawn in the same manner as that of Snakes; and they are further distinguished by the absence of plates of bone in the skin of the head and body. The group is confined to the warmer parts of the Old World (inclusive of Australia), although unknown in Madagascar. All the species are included in the genus *Varanus*, of which the largest living representative is the Kabara-goyu (*V. salvator*, **409**) of the Singalese. This attains a length of 7 feet, and, like some of the other species, is partially aquatic; but it was considerably exceeded in size by a fossil Monitor from N. India which, in its turn, was a dwarf to the extinct Giant Monitor of Queensland, of which a vertebra (**419**) is shown in the case. All the Monitors are carnivorous, many of them being in the habit of feeding largely on birds' eggs, which they hold and crack in their mouths while their heads are raised.

It will be noticed that the Monitors differ markedly from the typical arboreal Iguanas, both in shape and colouring; their bodies being depressed, instead of compressed, and their colour usually a mixture of black, brown, olive, and yellow. The reason of these differences is that these Lizards are terrestrial, and live among bushes, grass, rice, and other covert, to which their type of colouring assimilates them. By Europeans in India and Africa Monitors are generally mis-called Iguanas.

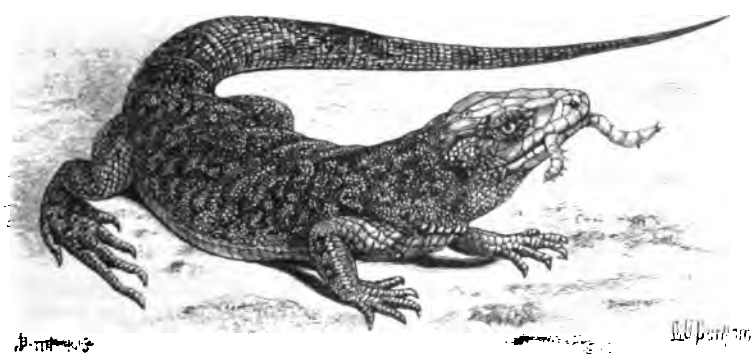
Case 19. The American Lizards typified by the Tejus (family *Teiidæ*) are characterised by the solid teeth, which are almost of the acrodont type, by the long and deeply cleft tongue, furnished with numerous papillæ, and the absence of bony plates or granules in the skin. Occasionally the limbs are somewhat reduced. The members of this family are arranged in nearly forty genera, and display great variety of form and habit. Some dwell in forests and are aboreal, others frequent hot and dry plains, while yet others are limbless, Blind-worm-like creatures. The largest member of the family is the Great

Teju (*Tupinambis teguixin*, **421**), which reaches a yard in length. *Dracæna guianensis* is peculiar in having cheek-teeth of a molar-like type. *Ameiva dorsalis* (**423**) is a smaller West Indian species.

The Amphisbænas (family *Amphisbænidæ*, **436–437**) are worm-like and for the most part limbless tropical Lizards which take their name from their power of progressing either forwards or backwards. They are degraded, or perhaps specialised types; and are characterised by having the body covered with soft skin, which forms numerous rings and shows only vestiges of scales. The genus *Chirotes* alone retains short and four-clawed front-limbs. About a dozen generic types are recognised, of which the typical *Amphisbæna* (**436**) contains the greatest number of species. Amphisbænas lead an underground burrowing existence, like worms; and are often found in ants' nests and refuse heaps. Their movements are worm-like, the soft, ringed skin enabling them to move with equal facility in either direction. Unlike other limbless Lizards and Snakes, which move in lateral undulations, Amphisbænas crawl in a straight line with slight vertical folds of the body. All are Tropical American. Case 20.

The common English Lizard and its allies are the types of a family (*Lacertidæ*, **440–445**) characterised as follows: The teeth are pleurodont, *i.e.* attached to the inner side of the margin of the jaws; the long tongue is forked, with either tubercles or folds; there are bony plates on the head; and the temporal region of the skull is roofed Case 20.

Fig. 36.



The Eyed Lizard (*Lacerta ocellata*); ⅓ nat. size. (No. **441**.)

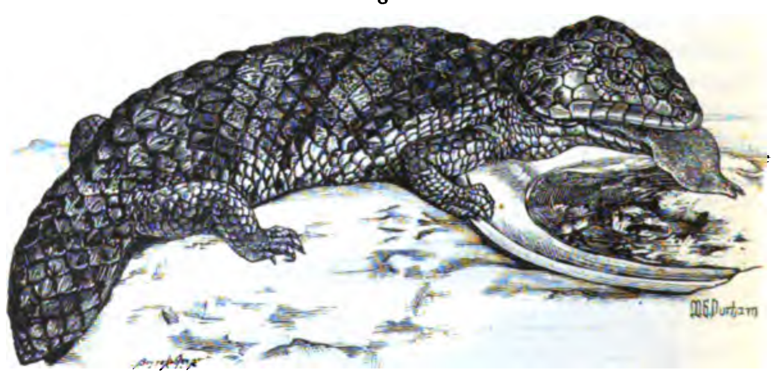
with bone. The family is restricted to the Old World and includes less than a score of genera. The most familiar forms of the typical

family are the Common Lizard (*Lacerta vivipara*), in which the young (from 6 to 12 in number) burst the eggs just before or just after they are laid, the Sand-Lizard (*L. agilis*, **443**), the Green Lizard (*L. viridis*, **442**), the Wall-Lizard (*L. muralis*, **444**), and the beautiful Eyed Lizard (*L. ocellata*, **441**, fig. 36). All of these are European, but only the first two occur in England. The Spanish Lizard (*Psammodromus hispanicus*) represents a genus distinguished by the absence of a semi-lunar collar of enlarged scales on the front of the neck.

Variation in the South European Wall-Lizard (*Lacerta muralis*) is illustrated by coloured figures.

The family *Gerrhosauridæ* (**438, 439**) comprises a small assemblage of African and Malagasy Lizards characterised by their pleurodont dentition, the long and slightly cleft tongue, which is furnished with tubercles, and the presence of bony plates in the skin of the head and body, roofing over the temporal region of the skull. In addition to the typical *Gerrhosaurus* (**439**), there are the genera *Tetradactylus*, *Cordylosaurus*, *Zonosaurus* (**438**), and *Tracheloptychus*.

Fig. 37.



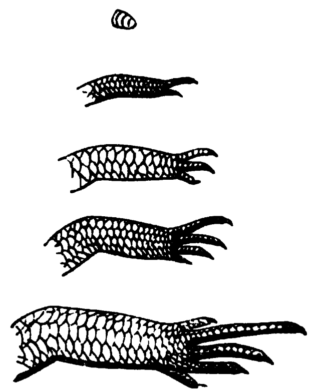
Stump-tailed Skink (*Trachysaurus rugosus*); ½ nat. size. (No. **374**).

Case 20. The Common Skink is the type of a large and cosmopolitan family of Lizards known as *Scincidæ* (**455–474**), or Skinks, and presenting the following characteristics. The dentition is pleurodont, *i.e.* the teeth are attached to the inner side of the margin of the jaws; the tongue is scaly and but slightly notched; and bony plates are developed in the skin of the head and body. Skinks prefer dry sandy ground, on which they move rapidly and in which they burrow; the frequent reduction or even loss of the limbs being connected with the burrowing habit. Most produce their young alive; the usual hard

egg-shell being frequently absent. About 400 species are known, which have been grouped in nearly 30 genera. The family attains its greatest development in the Australasian region.

One of the most remarkable types is the Stump-tailed Skink (*Trachysaurus rugosus*, **474**, fig. 37), recognisable by its large and rough scales and short tail. The Australasian *Tiliqua* (**457–458**) includes large species with stout button-shaped teeth. The True Skinks have 5-toed limbs with the lateral toes serrated; the common species (*Scincus officinalis*, **483**), which grows to about 8 inches, has a perfectly smooth skin, and wedge-like head. It was once esteemed a sovereign remedy for many diseases. *Mabuia* (**456**), with about 40 species, is remarkable for including one semi-aquatic form (*M. vittata*). The Eyed Skink (*Chalcides ocellatus*, **482**) of the Mediterranean countries, which grows to 10 inches, is a member of a genus in which the lower eyelid has a transparent "window," the scales are smooth and shiny, and the limbs short or rudimentary (fig. 38). A series of specimens illustrating the degradation of the limbs is shown.

Fig. 38.



Hind-legs of Skinks, to show the gradual abortion.

a, *Chalcides ocellatus.*
b, *Chalcides mionecton.*
c, *Chalcides tridactylus.*
d, *Lygosoma lineo-punctulatum.*
e, *Chalcides guentheri.*

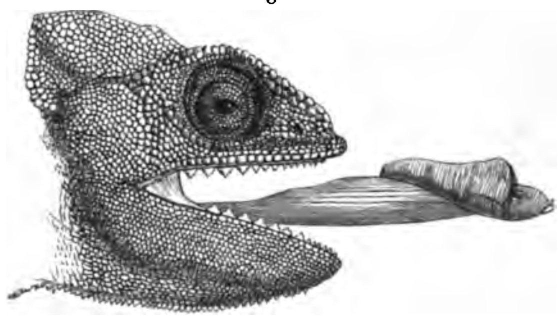
Sub-order III.—Rhiptoglossa.—Chamæleons.

Chamæleons (**446–454**) constitute by themselves not only the family *Chamæleontidæ*, but also the sub-order Rhiptoglossa—a group of equal value with the Lacertilia. From Lizards Chamæleons are distinguished by the structure of the tongue, which is club-shaped, and can be extended to a length equal to that of the whole body (fig. 39); and by the form of the head, which is somewhat helmet-shaped. There is no tympanum, or drum, to the ear, and no tympanic cavity. The long limbs are also of a peculiar type, having two of the toes opposed to the other three, so as to form an effective grasping foot (fig. 40). Clavicles, or collar-bones, as well as an Case 20.

inter-clavicle, are absent. The long tail, which is not of a brittle and renewable type, is prehensile and curled downwards when used as a grasping organ.

The skin is covered with granules in place of scales; and the

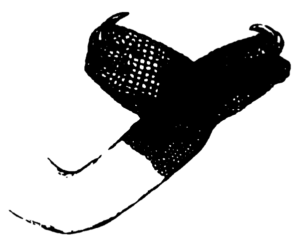
Fig. 39.



Head of the Common Chamæleon (*Chamæleon vulgaris*), with the tongue partially protruded.

eyes are very large, with the eyelids united into one fold, having a minute central opening. Each eye can be moved independently; and the movements of the limbs are slow and sluggish. As in all arboreal Lizards, the body of the Chamæleons is much compressed

Fig. 40.



Fore-foot of a Chamæleon.

laterally. Chamæleons are famed for the capacity of changing colour according to the nature of their surrounding—a power which they share, however, with certain Lizards such as those of the genus *Calotes*. They feed on flies and other insects, which are caught at a distance of several inches on the sticky end of the protrusile tongue (fig. 39). Most species lay eggs, but a few are viviparous.

In the majority the prevailing colour is brown or green, but in the

Arabian *Chamæleon calyptratus* (**451**), of which a specimen is exhibited, the body is marked by vertical bands of blue and yellow. All the species are confined to the warmer parts of the Old World.

Fig. 41.

The Common Chamæleon (*Chamæleon vulgaris*); ⅔ nat. size. (No. **446**.)

Order VII.—ICHTHYOPTERYGIA (*Extinct*).
(Case 17.)

The Ichthyosaurs were Whale-like marine Reptiles which flourished from the period of the New Red Sandstone, or Trias, to that of the Chalk. The limbs are modified into paddles, in which the bones of the digits exceed the normal number, and are more or less shortened and broadened so as to form a pavement-like structure. The teeth, which are generally fluted, are implanted in grooves in the long jaws. A ring of overlapping bones is developed in the white (sclerotic) of the eye. The bodies, or centra, of the vertebræ are short, doubly-cupped, and separate from the neural arches.

The Triassic *Merriamia* and *Mixosaurus* were comparatively small Reptiles, in which the ribs of the trunk are single-headed, the radius

and ulna of the front-paddle (like the tibia and fibula in the hind-limb) are elongated and separated by a wide cleft, while the other bones of the paddles are also somewhat elongated, often notched on

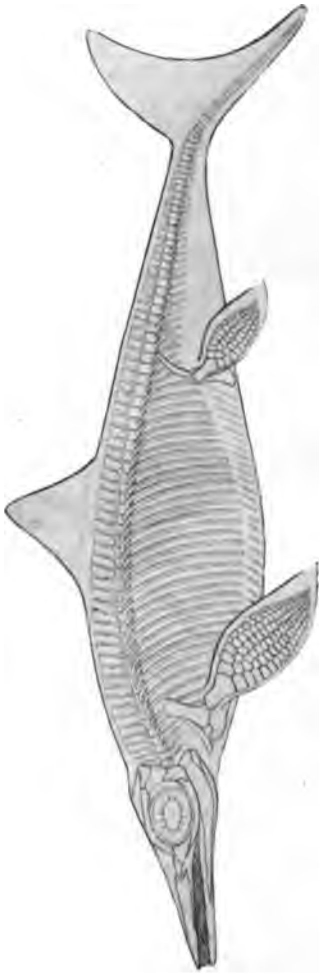


Fig. 42.

Skeleton of *Ichthyosaurus communis*, with outline of body and fins indicated in shading, from the Lower Lias of Lyme Regis; about one-thirtieth nat. size.

one or both borders, and arranged in three rows. In *Ichthyosaurus* (**347**, **348**), on the other hand, the radius and ulna are transversely expanded and in apposition, while the other bones of the paddle are also very short and broad, and the ribs are two-headed. In certain species, the paddle-bones are arranged in three longitudinal rows,

with notches on the outer border of those of the front row; but in another group there are five or more longitudinal rows of these bones, which are generally without marginal notches. In *Ophthalmosaurus* (**351**), of the Kimmeridge Clay, a third bone (the pisiform) articulates with the humerus, an analogous condition obtaining in the hind-limb. Both in *Ophthalmosaurus* and the allied American *Baptanodon* the teeth were rudimentary.

Order VIII.—CHELONIA.

Tortoises and Turtles.

(Cases 6 to 10.)

Tortoises, Terrapins, and Turtles, which collectively constitute this order, are distinguished from all other Reptiles by the toothless horn-covered jaws, and the enclosure of the body in a bony shell, which may or may not be covered with horny shields. The shell, which consists of an upper half, or carapace, and a lower portion, or plastron, is supported by the spines of the vertebræ and the ribs; and consequently Chelonians present the unique peculiarity that the shoulder and pelvic girdles are situated within the ribs. The limbs, which are five-toed, may be adapted for walking (Tortoises) or modified into paddles (Turtles). Each rib articulates with the vertebræ by a single head, and the quadrate-bone is firmly united to the skull. This order dates from the Triassic epoch.

Chelonians are arranged in two main divisions: the Athecæ and the Thecophora. In the former group, now represented by the Leathery Turtle, or Luth, the vertebræ and ribs are free from the carapace (fig. 45), which is composed of small polygonal plates like mosaic, and covered with horny skin. In the second group, the vertebræ and ribs are fused with the carapace (fig. 44), which is composed of a number of bony plates of variable size, the names and relations of which are shown in case 6. In this group, as shown in the figure on page 52, the number and size of the horny shields do not accord with those of the underlying bones.

The Thecophora are subdivided into the following three groups:

1. Cryptodira, or those in which the head is retracted in a vertical plane by an S-like flexure of the neck (fig. 55), and the pelvis is not attached to the plastron.
2. Pleurodira, or those in which the head is retracted in a horizontal plane by a lateral flexure of the neck (fig. 56), and some of the bones of the pelvis are welded to the plastron.

3. **Trionychoidea**, or those with very flat oval or almost round shells, covered with soft leathery skin, and broadly webbed limbs, of which only the three middle toes are clawed.

The following table shows the chief sub-divisions of the group:

Order CHELONIA.

I. Section Athecæ.
   Family *Sphargidæ*, or *Dermochelydidæ*.

II. Section Thecophora.

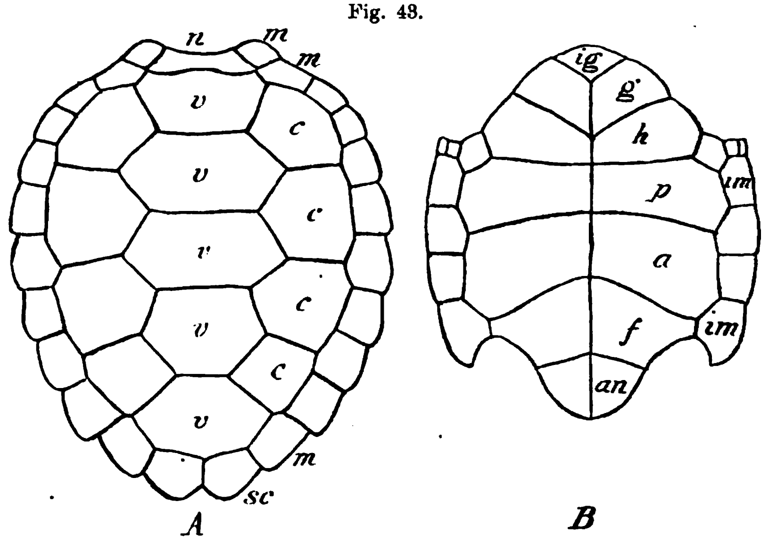
i. Sub-order Cryptodira.
   Family *Chelydridæ*.
   ,, *Dermatemydidæ*.
   ,, *Cinosternidæ*.
   ,, *Platysternidæ*.
   ,, *Testudinidæ*.
   ,, *Chelonidæ*.

ii. Sub-order Pleurodira.
   Family *Pelomedusidæ*.
   ,, *Chelydidæ*.
   ,, *Carettochelydidæ*.
   ,, *Plesiochelydidæ*. } Extinct.
   ,, *Miolaniidæ*. }

iii. Sub-order Amphichelydia.
   Family *Pleurosternidæ* (extinct).

iv. Sub-order Trionychoidea.
   Family *Trionychidæ*.

Fig. 43.



Upper (*A*) and Lower (*B*) Shells of the Green Turtle (*Chelone mydas*), to show arrangement of the horny plates.

n. Nuchal.	*sc.* Supracaudal.	*g.* Gular.	*a.* Abdominal.
v. Vertebral.	*im.* Inframarginal.	*h.* Humeral.	*f.* Femoral.
c. Costal.	*ig.* Intergular.	*p.* Pectoral.	*an.* Anal.
m. Marginal.			

Fig. 44.

SKELETON OF LUTH OR LEATHERY TURTLE (*Dermochelys coriacea*).
To show complete separation of shell from the ribs. (No. 186A.)

Fig. 45.

SKELETON OF GREEN TURTLE (*Chelone mydas*).
To show union of shell with ribs. (No. 182.)
(From specimens in the Museum.)

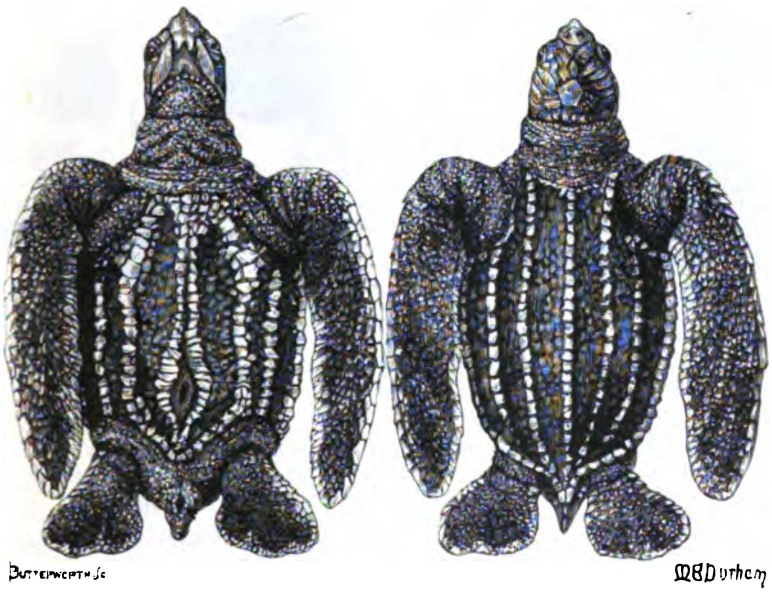
[*To face page* 42.

Section ATHECÆ.

Leathery Turtles.

The only living representative of this group is the Luth or Leathery Turtle (*Dermochelys coriacea*, **180**, fig. 46), the largest of Table-case.

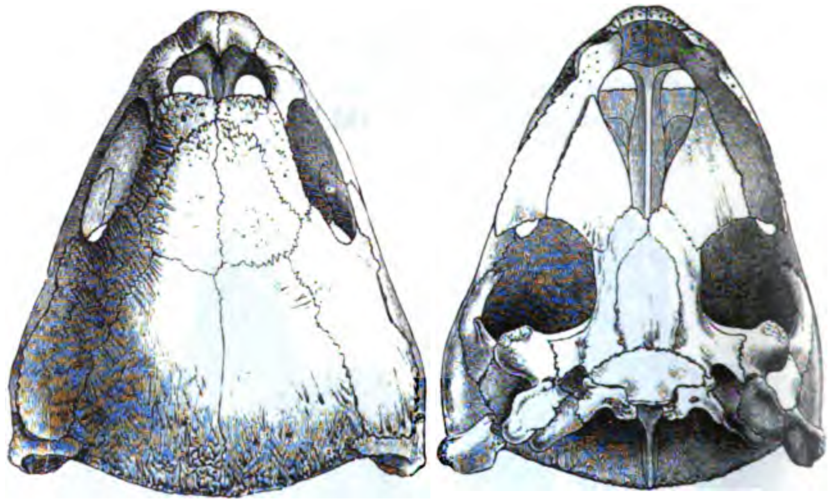
Fig. 46.



Luth, or Leathery Turtle (*Dermochelys coriacea*); young specimens; lower and upper view. (No. **180**.)

existing Chelonians, which sometimes measures as much as six and a half feet from the muzzle to the hind border of the carapace, the length of the shell being about four feet. Such a specimen would weigh about half a ton. In common with a number of allied extinct Turtles, mostly referable to the family *Sphargidæ*, or *Dermochelydidæ*, the Luth is characterised by the vertebræ and ribs being free from the carapace, which is composed of small polygonal plates of bone, covered with a continuous leathery skin. The limbs are in the form of paddles, and the neck cannot be withdrawn into the shell; there

Fig. 47.

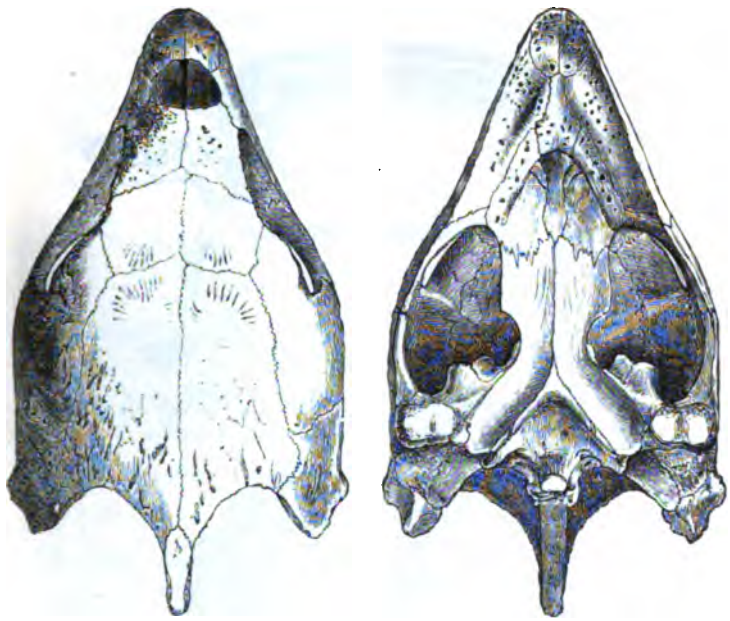


Upper and Lower views of Skull of Luth, or Leathery Turtle (*Dermochelys coriacea*), showing the absence of a secondary floor to the palate and the consequent forward position of the posterior nostrils.

is no plastron. The Luth is met with in all tropical seas, though it is everywhere rare; specimens are occasionally carried by the Gulf Stream as far north as England. In spring these Turtles resort to the Bahamas, Tortugas, and the coast of Brazil, to lay their eggs on sandy shores. They are exclusively carnivorous, feeding chiefly upon mollusks, crustaceans and fishes. The flesh is unwholesome. This species is represented in the gallery by the cast of a fine specimen (**180**) caught on the coast of Trevandrum, Travancore, India, and presented by the director of the Trevandrum Museum, and also by the skeleton shown in fig. 45. Remains of a much larger extinct species (*Eosphargis gigas*) occur in the London clay.

The accompanying illustrations (figs. 47 and 48) are intended to show the remarkable difference of the bony palate of the Luth from that of ordinary Turtles.

Fig. 48.



Upper and Lower views of Skull of Hawksbill Turtle (*Chelone imbricata*), showing the presence of a secondary floor to the palate and the consequent backward position of the posterior nostrils.

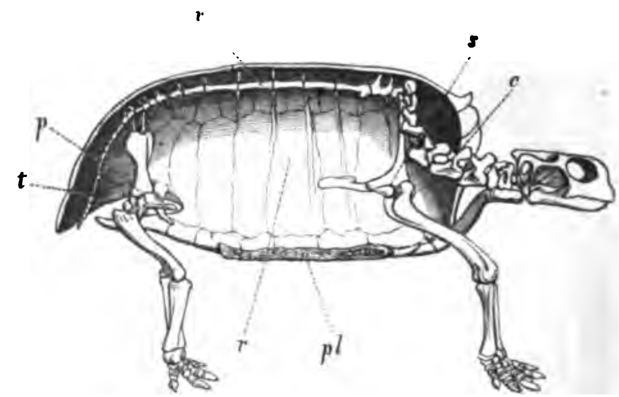
Section THECOPHORA.

Sub-order I.—Cryptodira (S-necked Tortoises).

The Cryptodira, or S-necked Tortoises, which constitute the majority of living Chelonia, are characterised, as already mentioned, by the head being drawn in by an S-like bending of the neck in a vertical plane so that the head occupies the centre of the front of the shell (fig. 55). Unlike the Pleurodira, in which the bones of the pelvis are welded to the upper and lower shells, their bones are free. Specimens are exhibited in case 9 to illustrate the essential differences between the Cryptodira and Pleurodira.

Of the three living representatives of the family *Chelydridæ* (**75–77**), Case 6.

Fig. 49.



Skeleton of a Land Tortoise, in a vertical section through the carapace, showing the mode of retracting the neck in a vertical plane.

c, neck; *v*, dorsal vertebræ; *t*, tail; *r*, costal plates of carapace; *pl*, plastron; *s*, shoulder-bones; *p*, pelvis.

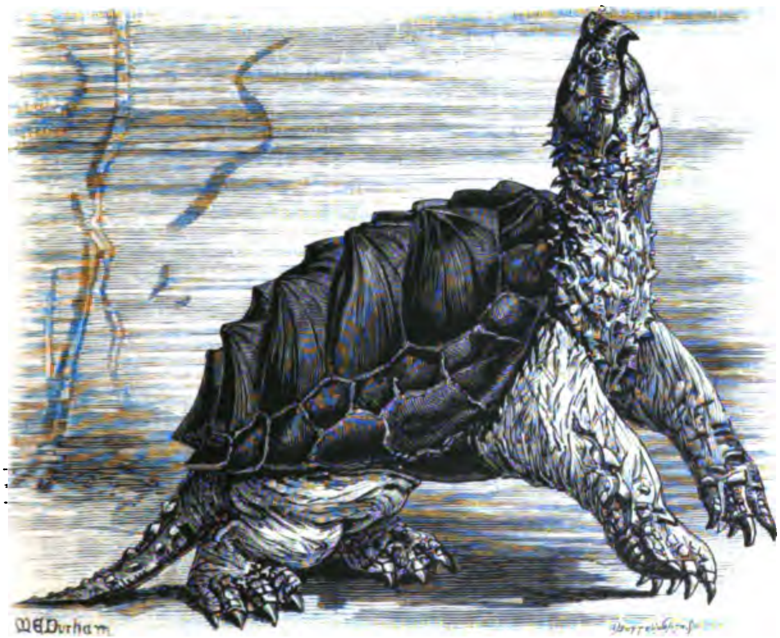
or Snappers, two are from North America, while the third is from Ecuador; fossil species occur in the Tertiary rocks of Europe. The nuchal bone of the carapace has rib-like processes underlying the costals. The large head (which is furnished with a beak) and neck cannot be withdrawn into the shell; and the temporal region of the skull is partially roofed. The long tail has the articular surfaces of most of the vertebræ cupped behind. Inframarginal horny shields separate the marginals of the carapace from the abdominals of the plastron, which is cruciform and united to the carapace by a narrow bridge. Temminck's Snapper (*Macroclemmys temmincki*, **75**, fig. 50) has a ridged, while the two species of *Chelydra* (**76** and **77**) have a smooth shell.

Snapping Turtles live in deep pools or sluggish streams, keeping mostly to the bottom, although rising from time to time to breathe, and occasionally landing. They are carnivorous, feeding on fish and waterfowl, and inflict dangerous bites.

Case 6. The Tortoises of the small Central American family *Dermatemydidæ* (**73** and **74**), for which there is no collective English name, resemble the *Chelydridæ* in that the nuchal plate of the carapace gives off a pair of rib-like processes underlying the costals; and also by the pectoral shields of the plastron being separated from the marginals by a

series of inframarginals. They differ by the open temporal region of the skull, as well as by the small size or absence of the gular shields, and the short tail. Some of the hinder costal plates overlap the neurals so as to meet in the middle line. In *Dermatemys* (**74**) the large plastron, which is firmly joined to the carapace, carries at least eleven shields, and there are four inframarginals. In *Staurotypus* (**73**) the plastron is cruciform, with the front flap movable, and

Fig. 50.



Temminck's Snapper, or Alligator-Terrapin (*Macroclemmys temmincki*); ⅛ nat. size. (No. **75**.)

seven or more shields; the number of inframarginals being two. Nothing is known of the habits of either group.

The Mud-Terrapins (family *Cinosternidæ*, **66–72**) resemble the *Chelydridæ* and *Dermatemydidæ* in the presence of rib-like processes to the nuchal bone of the carapace, but differ from these and all other Chelonia in the absence of an entoplastral bone to the plastron, which thus has eight, in place of the usual nine, bones. The neck can be completely retracted within the shell, the temporal region of the Case 6.

skull is completely open, and the tail is short, with the bodies of the vertebræ cupped in front. Some of the neural plates of the carapace are hidden by the costals meeting in the middle line. Inframarginal shields are present, but do not completely cut off the marginals from the abdominals. In some species, the plastron has two transverse hinges, so that the shell can be completely closed.

The Burmese Casked Terrapin (*Platysternum megacephalum*, **68**), representing the family *Platysternidæ*, differs from the three preceding families by the absence of rib-like processes to the nuchal bone of the carapace. In this respect it agrees with the *Testudinidæ*, from which it is distinguished by the presence of inframarginal shields between the marginal and the abdominal shields of the plastron. The head is very large, and the temporal region of the skull completely roofed over by bone, in a manner unknown in any other Terrapin. The tail is long, with the articular ends of most of the vertebræ cupped behind. Except that it is aquatic, nothing is known of the habits of this rare and curious Terrapin.

Cases 6–7. In the more typical Tortoises and Terrapins, constituting the large family *Testudinidæ* (**78**–**175**), the nuchal bone of the carapace lacks rib-like processes; and, owing to the absence of inframarginals, the abdominal shields of the large plastron abut on the marginals. The head, limbs, and tail can be drawn within the shell; the temporal region of the skull is open, and the articular ends of the vertebræ of the short tail are cupped in front. From the terrestrial herbivorous Tortoises to the aquatic carnivorous Batagurs there is a transition through the Terrapins. The former have the shell vaulted and lay ~~spherical~~ eggs; while in all the aquatic forms the shell is depressed, the feet are webbed and have longer claws, and the eggs are ~~oval~~ generally sausage-shaped

Case 6. The Hinged Tortoises (*Cinyxis*, **141**, **142**) of Tropical Africa are unique in having the hinder part of the carapace movable, the hinge passing between the 7th and 8th marginal and the 4th and 5th costal plates. There is no hinge in the plastron. In some species the margins of the carapace are smooth, but in others they are serrated and turned up. Of the latter type is *Cinyxis erosa* (**142**), a species further remarkable for the absence of a nuchal shield to the carapace, and the prolongation of the front of the plastron, which forms a fork, covered by the intergular shields. This species lives on vegetable substances, and is said to be partly aquatic, but *C. belliana* (**141**) is believed to be entirely terrestrial. The Spider-Tortoise (*Pyxis arachnoides*, **143**) of Madagascar is a purely terrestrial species, without any joint in the

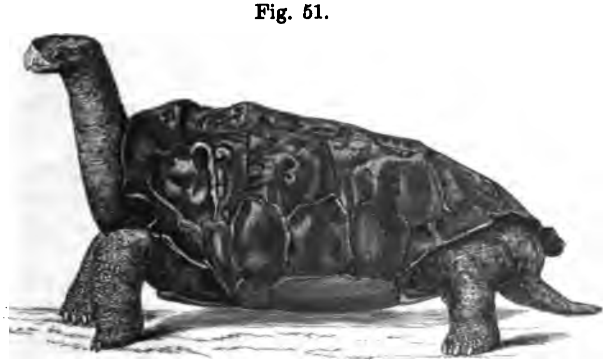
carapace, but with a hinge in the plastron. It does not exceed four inches in length.

The typical Land Tortoises included in the genera *Testudo* (**147–176**) and *Homopus* (**144**, **145**) are characterised by their vaulted shells, in which the plastron is normally without a hinge and firmly united by a strong bridge to the carapace. The feet, of which the hind-pair are club-shaped, are not webbed, and have not more than two joints to each toe. On the front of the fore-limbs the skin carries stout horny shields, sometimes underlain by bony nodules, and large shields cover the head. The tail is short. Usually the neural bones of the carapace are alternately quadrangular and octagonal, but they may be hexagonal, with the shorter lateral surfaces posterior; the costals are alternately wide and narrow at the ends. Generally the supracaudal shield is single. Tortoises of the genus *Testudo* range throughout the warmer parts of the world except Australasia and some of the Malay Islands. Case 7.

The majority of existing Land Tortoises are of small or medium size, but a number of island species attained much larger dimensions.

Within historic times the distribution of species of *Testudo* large enough to be called gigantic has been restricted to two areas. These are the Galapagos (Tortoise) Islands, on the Equator off the west coast of South America, and certain islands on the western side of Case 7 and adjacent table-cases.

Fig. 51.



The Abingdon Island Saddle-backed Tortoise (*Testudo abingdoni*), remarkable for the thinness of its shell, from the Galapagos group. (No. **153**.)

From a specimen in the Museum.

the Indian Ocean, including the Mascarenhas (Réunion, Mauritius, and Rodriguez), the Aldabra group, the Amirantes, and the

E

The few species of the African genus Homopus ~~[illegible]~~ the median ridge on the alveolar surface of the palate which is present in Testudo.

Seychelles. From Madagascar they disappeared at an earlier date; earlier still Giant Tortoises inhabited most of the continents. Formerly the Tortoises swarmed on the above-named islands in the Indian Ocean; but they were carried off by the ship-load for food, and some of the species are only known by specimens which had been transported from their native homes. These Tortoises are vegetable-feeders, and in the Galapagos subsist chiefly upon succulent cactuses, leaves, and berries. At certain times of the year they collect at particular pools and springs, to which they travel long distances, forming regular, well-trodden paths. They ascend the volcanic cones to a height of 4000 feet. These Tortoises live to a great age. For instance Marion's Tortoise (*Testudo sumeirei*), living in 1902 at Port Louis, Mauritius, was brought to that island in 1766 from the Seychelles, of which it is a native; at the time of transport it was probably a century old. The North Aldabra Tortoise (*T. gigantea*, **148**) survives only in the Seychelles, but the South Aldabra species (*T. daudini*, **152**) is still found in its native island. Specimens of the former weigh between 350 lbs. and 400 lbs. In some of the species, as in *T. ephippium* (**149**) and *T. abingdoni* (**153**, fig. 51) of the Galapagos, and the extinct *T. vosmaeri* of Rodriguez, the bony shell is extremely thin, being reduced to detached plates in the two former.

The largest specimen exhibited is that of the North Aldabra *T. gigantea* (**148**); the shell of an extinct species from Madagascar (*T. grandidieri*, **154**) is shown alongside.

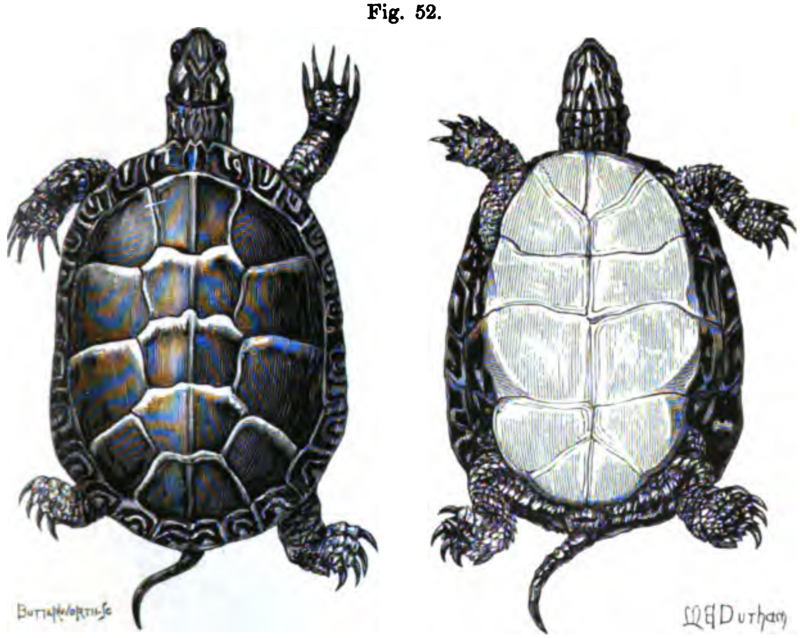
The two North American species of Box-Tortoise (*Cistudo*, **138**–**140**) take their name from the circumstance that the plastron (which is attached to the carapace by ligament) is divided by a transverse hinge into two movable lobes in such a manner that, when the head, limbs, and tail are withdrawn, the shell can be completely closed. The carapace is vaulted, the toes are almost completely free, and the tail is short.

Case 6. Box-Tortoises are really Terrapins which have taken to a life on land, and to this they are so thoroughly adapted, that they are drowned if thrown into water. The shape of the head, the vaulting of the shell (which is black and yellow or orange-brown in colour), and the short front-toes are adaptations to terrestrial life. On the other hand, the long hind-toes and broad feet, the smooth covering of the head, the mainly carnivorous habit, and the oval eggs proclaim descent from aquatic forms. The Carolina species varies greatly in colour, the eyes being red in the males

and brown in the females. Box-Tortoises are kept as pets in the United States, and attain a great age.

The Pond-Tortoises (*Emys*, **109**, **110**) are the typical and least specialised members of a large number of, for the most part aquatic, genera, which diverge in one direction into the thoroughly aquatic Batagurs and in the other into the land Tortoises. They have more or less depressed shells and generally webbed feet; and the majority are carnivorous. The distinctions between the different genera are Case 6.

Fig. 52.



The Painted Terrapin (*Chrysemys picta*); ½ nat. size. (No. **86**.)

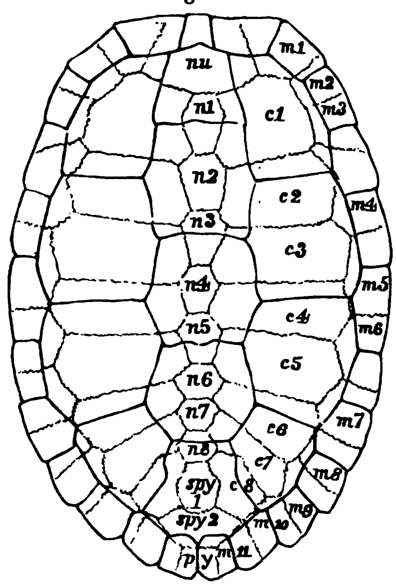
chiefly based on the form and relations of the bones of the shell, the structure of the skull, etc., so that they are not apparent externally.

The Pond-Tortoises, of which there is one European and one North American species, are thoroughly aquatic, and feed on small fishes, worms, etc.; during winter they bury themselves in the mud. Nearly allied is *Clemmys* (**111–115**), one European species (*C. leprosa*, **115**) of which is characterised by its offensive smell and the growth of a fungus on the shell. The well-known salt-water Edible Terrapin (*Malacoclemmys terrapin*, **91**), of the United States, belongs to a kindred genus distinguished by the breadth of the palatal surface of

the upper jaw. The Painted Terrapin (*Chrysemys picta*, **88**, fig. 52) typifies another North American genus, most of the members of which are distinguished by their bright colouring and the elaborate patterns on the shell especially when young. *Ocadia* (**101**) is now exclusively Chinese, although fossil species occur in the Tertiary rocks of Europe. *Bellia* (**102**, **103**) and *Damonia* (**105–108**) are Indian, the former easily recognised by the balloon-shaped vertical shields of the carapace. Another Indian genus is *Geoëmyda* (**127–130**), the members of which are to a great extent terrestrial, and thus indicate a transition towards those species of land Tortoises, like *Testudo emys* (**172**), in which the shell is flatter than usual.

Case 6. A group of aquatic Oriental Tortoises, for the most part of large size, are (from the Indian name of the typical species) collectively designated Batagurs. They include the genera *Kachuga* (**96–99**),

Fig. 53.

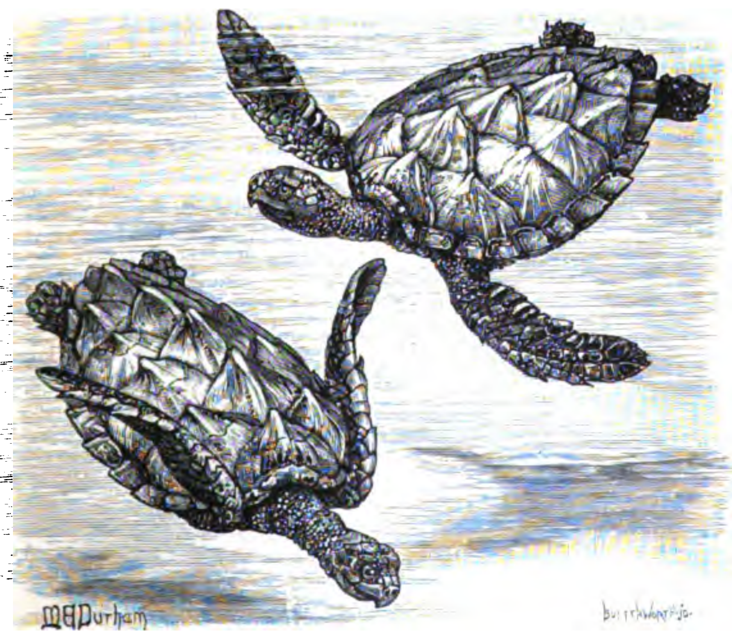


Carapace of the Thurgi Batagur (*Hardella thurgi*), with the horny shields removed; much reduced in size. The wavy lines show the divisions (or sutures) between the bones; the firm lines indicate those between the overlying horny shields. *c*. 1–8, costal bones; *m*. 1–11, marginal bones; *n*. 1–8, neural bones; *nu*. nuchal bone; *py*. pygal bone; *spy*. 1, 2, suprapygal bones. (No. **131**.) Note that the horny plates do not correspond with the bony ones.

Callagur (**94**), *Batagur* (**78**), *Hardella* (**131**, fig. 53), *Brookia* (**100**), and *Liemys* (**93**), of which the two latter are confined to Borneo. They are characterised by the strength of the buttresses connecting the upper with the lower shell, which project as vertical partitions into the shell. In *Kachuga* the 4th vertebral shield is so elongated as to cover 4 or 5 of the subjacent neural bones; and in the small *K. tectum* the middle line of the vaulted shell forms a ridge terminating in a protuberance on the 3rd vertebral. Of the other three Indian genera, *Batagur* is distinguished by having two ridges on the palate (in place of one), and only four claws in the fore-limb. *Kachuga tectum* (**96**) is one of the commonest Tortoises in the dykes about Calcutta.

The true Turtles, family *Chelonidæ*, have paddle-like limbs, and a Case 8.

Fig. 54.



Young Hawksbill Turtles (*Chelone imbricata*); ½ nat. size. (No. **181**.)

flattened heart-shaped carapace, composed of comparatively few bones, firmly welded to the ribs and vertebræ, and covered with horny shields. The short neck cannot be completely drawn into the shell, and the temporal region of the skull is roofed with bone (fig. 48). There is no

rib-like process to the nuchal plate of the carapace; the entoplastron of the lower shell (as in the *Chelydridæ*) is dagger-shaped. Each flipper has one or two claws. The existing members of the family are marine, but the females come ashore on sandy coasts to lay their spherical eggs. In the edible Green Turtle (*Chelone mydas*, **182**) the horny shields, of which there are four costal pairs, do not overlap, and there are vacuities between the costal and marginal bones of the carapace. The Hawksbill (*C. imbricata*, **181**, fig. 57), the chief source of commercial "tortoise-shell," is distinguished by the circumstance that, except in old age, the shields of the carapace overlap like slates on a roof. The Loggerhead (*Thalassochelys caretta*, **179**), the largest of all, differs from the others by having at least five pairs of costal horny shields on the carapace, as well as by the obliteration of vacuities in the latter when adult. Of extinct forms, the Eocene and Cretaceous *Lytoloma* has the secondary bony floor of the palate prolonged backwards so as to cause the posterior nostrils to open near the occiput; the symphysis of the lower jaw being also extended backwards. *Allopleurum hofmanni*, a gigantic species of the Upper Cretaceous, is allied to *Chelone* in the structure of the shell; specimens are exhibited in the Geological Department.

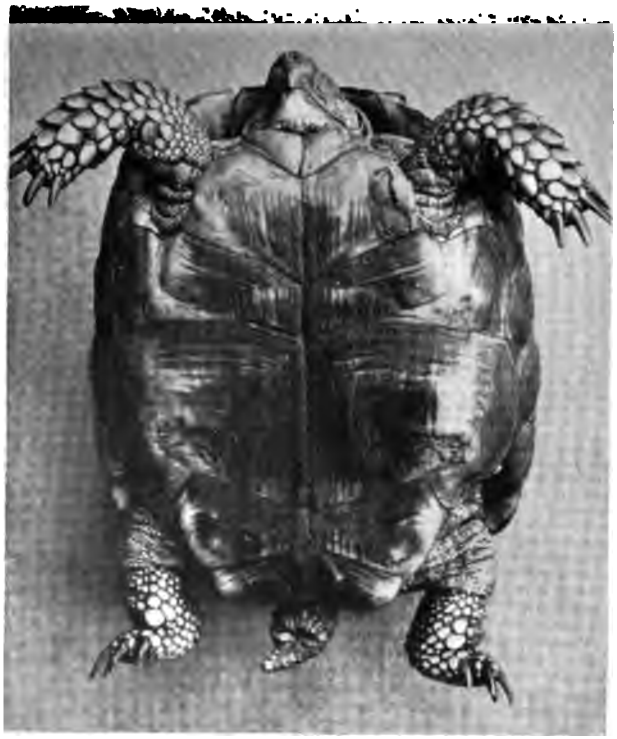
Commercial tortoise-shell of the best quality is yielded only by the Hawksbill; specimens are exhibited to show this product in its raw state and when polished.

Sub-order II.—Pleurodira (Side-necked Tortoises).

The chief distinctive characteristics of this group, which is confined at the present time to the southern hemisphere, are given above on page 41. The most easily seen of these is the manner in which the head is withdrawn into the shell by a lateral movement of the neck, as shown in fig. 56.

Case 9. The family *Pelomedusidæ* is typified by the African and Malagasy genus *Pelomedusa* (**210**), but also includes the Great Arrau Tortoise, or "Turtle," *Podocnemis expansa* (**204**), of the Amazons. In all the members of this group the neck is completely retractile within the shell, and the plastron has eleven bones, in consequence of the presence of a pair of mesoplastral elements (fig. 57), which, however, meet in the middle line only in *Sternothærus* (**212**). *Podocnemis* differs from *Pelomedusa* by the roofing-over of the temporal region of the skull. The female of the Great Arrau Tortoise is much larger than the male. To the natives of Amazonia this species is of great commercial

Fig. 55.



A Cryptodiran Tortoise (*Homopus arcolatus*).
To show how the head is withdrawn by an **S**-like curve of the neck in a vertical plane.

Fig. 56.

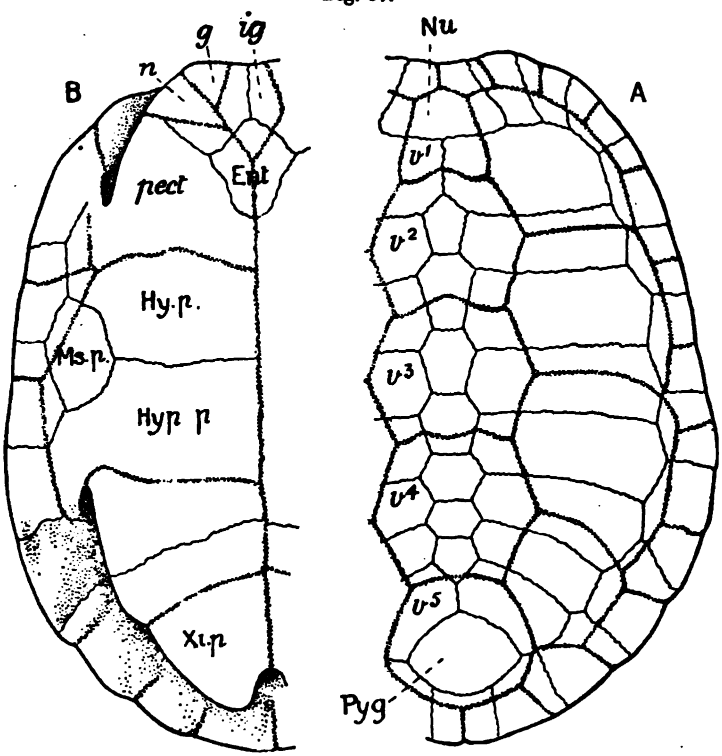
A Pleurodiran Tortoise (*Sternothærus niger*).
To show mode of retracting the head by a lateral flexure of the neck.

(Both figures from living specimens.)

[*To face page* 54.

importance, on account of the food-supply afforded by its flesh and eggs. Most of the eggs are converted into oil, which is used either for food or for burning. · The ~~soft~~-shelled eggs are laid in holes dug /hard

Fig. 57.



Right halves of Upper (*A*) and Lower Shells (*B*) of an extinct Egyptian Side-necked Tortoise (*Stereogenys cromeri*) to show presence of a mesoplastral bone (*Ms.p.*).

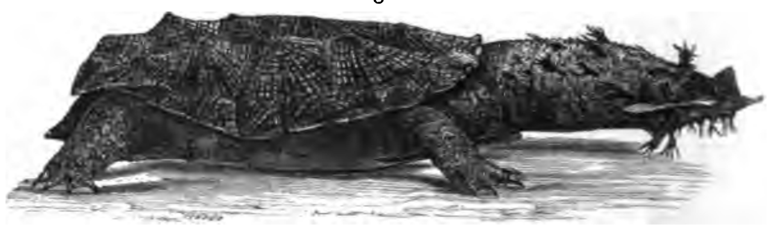
ig. intergular; *g.* gular; *n.* humeral; *pect.* pectoral shields; *nu.* nuchal; v.^{1}–v.^{5} vertebral; *Pyg.* pygal; *Hy.p.* hyoplastral; *Hyp.p.* hypoplastral; *Ent.* entoplastral bones.

by the females in the sand. The adults, which are mainly aquatic, subsist chiefly on fruits falling from the overhanging trees into the water.

The Matamatas, as the members of the family *Chelydidæ* may be collectively called (although that name properly belongs only to the Case 8.

typical South American species), differ from the *Pelomedusidæ* by the circumstance that the neck cannot be completely withdrawn into the shell, and likewise by the absence of a mesoplastral element in the plastron, which thus includes only nine bones. A nuchal shield, which is invariably wanting in the *Pelomedusidæ*, may be present on the carapace in this family. The true Matamata (*Chelys fimbriata*, **185**, fig. 58) is a very remarkable creature, carnivorous in habit, and passing its time at the bottom of the Brazilian rivers. The shell is raised into several knob-like prominences, and the skin of the neck and the sides of the head are developed into a number of moss-like processes, which probably serve to attract fishes within reach. On these fishes and other vertebrates the Matamata feeds; owing to the weakness of the creature's jaws, it is probable that they are swallowed whole.

Fig. 58.



The Matamata Tortoise (*Chelys fimbriata*); reduced. (No. **185**.)

Hydromedusa (**202**), *Platemys* (**200**), *Rhinemys* (**195**), and *Hydraspis* (**192**) are also South American, but the other kinds are Australasian.

Case 8. The extinct Horned Tortoises forming the family *Miolaniidæ* (**193**, **194**) are gigantic, and apparently Pleurodiran, species, characterised by the presence of large flanges and prominences on the skull, one pair of which resembles horns in form and position. The tail is also invested in a bony armour recalling that of the Armadillos among Mammals. The geographical distribution of the family is very remarkable, species of the typical and only genus occurring in Australia and Lord Howe Island on the one hand, and in Patagonia on the other.

Sub-order III.—Amphichelydia (*extinct*).

Family *Pleurosternidæ*.

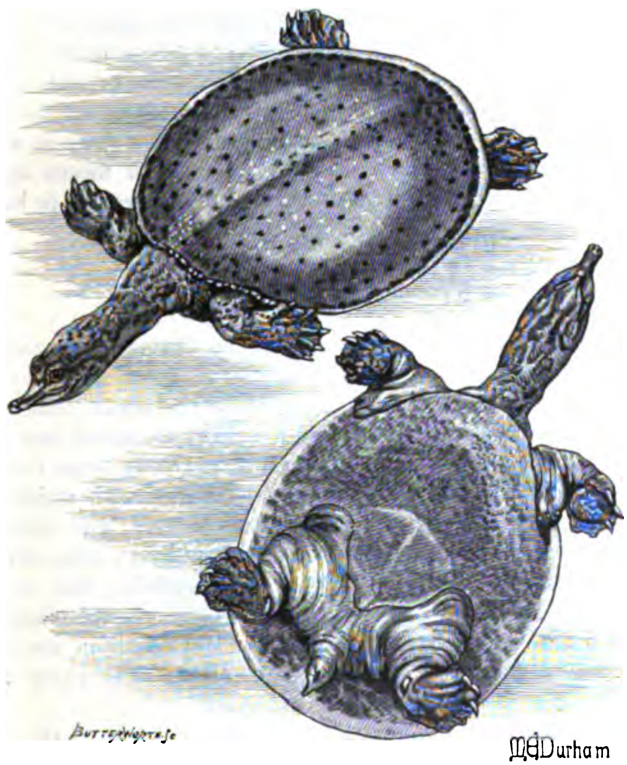
Case 9. The extinct Oolitic Tortoises of this family, like *Pleurosternum bullocki* (**203**), resemble the living *Sternothærus* among the *Pelome-*

dusidæ in having mesoplastral bones (fig. 57) which extend completely across the lower shell to meet in the middle line. They differ from living Pleurodira in that when the pubic bones of the pelvis articulate with the xiphiplastral elements of the plastron, the union is not by suture or anchylosis; hence they are assigned to a distinct group, the Amphichelydia.

Sub-order IV.—Trionychoidea (Soft Tortoises).

The Soft River Tortoises, or Mud-Turtles (family *Trionychidæ*, fig. 59), which retract the head and neck in a vertical plane with an Case 10.

Fig. 59.



Young American Soft Tortoises (*Trionyx ferox*). (No. 226.)

S-like flexure, after the manner of the Cryptodira, constitute a group of equal rank with the latter. They are characterised by the flatness

of the oval or nearly round shell, which is sculptured externally, and covered with leathery skin instead of horny shields. The toes are extensively connected by webs, but only the three inner ones on each foot are clawed. In the plastron the entoplastral is chevron-shaped. Soft Tortoises are carnivorous, and widely distributed; they date from the Cretaceous epoch.

Most of the species belong to the typical genus *Trionyx* (**222–230**), nearly allied to which are the Oriental genera *Chitra* (**220**) and *Pelochelys* (**221**), the former distinguished by the elongated skull and forward position of the eyes, and the latter by an intermediate condition in these respects. The African *Cycloderma* (**217**) and *Cyclanorbis* (**218**), together with the Indian *Emyda* (**219**), differ not only in the nature of the sculpture and the form of the bones of the lower shell, or plastron, but likewise in possessing a pair of flaps of skin on the lower surface beneath which the hind-limbs can be withdrawn.

Many of the species have curious eye-like spots on the back, and the long extensile neck is often marked with yellow spots on a green ground. Indeed, the native Indian name *Chitra* means spotted. These Tortoises, when of large size, are highly dangerous to bathers.

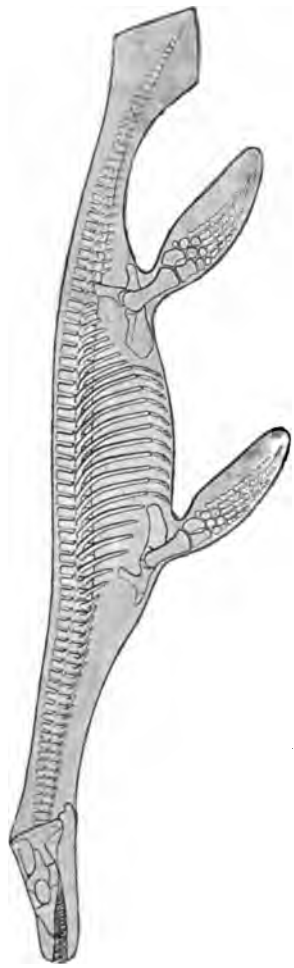
Order IX.—SAUROPTERYGIA (*extinct*).
(Case 16.)

The larger marine Plesiosaurs may be distinguished from the Ichthyopterygia by the absence of a ring of bones in the eye, and by the structure of the paddles, in which the bones, although in excess of the usual number, are more or less elongated, and do not articulate to form a pavement. In the more typical forms the upper arches of the vertebræ are welded to the bodies, with which alone (in all cases) the single-headed ribs articulate. The teeth have separate sockets, and there is but one (the lower) temporal arch. Abdominal ribs are developed on the under surface. The bones of both shoulder-girdle and pelvis develop large ventral plates; the coracoids and sometimes even the scapulæ meeting in the middle line. The skin appears to have been naked. The group ranges from the Trias to the Chalk.

In the typical *Plesiosaurus* (**336**, fig. 60) of the Lias the head is comparatively small and the neck elongated, similar features occurring in the Jurassic *Cryptoclidus* (**340**) and *Murænosaurus* and the Cretaceous *Cimoliosaurus*, which are distinguished by the structure of the shoulder-girdle and pelvis. In the gigantic *Pliosaurus* (**339**) of the

Oxford and Kimmeridge Clays the head is large and the neck short, while the teeth may be trihedral instead of conical. The upper arches of the vertebræ were loosely attached to the bodies.

Fig. 60.



Skeleton of a typical Plesiosaur (*Plesiosaurus macrocephalus*) with outline of body and tail-fin indicated in shading, from the Lower Lias of Lyme Regis; about one-eighteenth nat. size. (Compare No. **338**.)

The smaller Triassic representatives of the group, such as *Neusticosaurus* (**343**) and *Lariosaurus* (**342**), were probably amphibious or terrestrial, and had limbs of a more normal structure. They approach the primitive Rhynchocephalia.

In some restorations, Plesiosaurs are represented with the neck

curved in a swan-like fashion ; but from the fact that the vertebræ of the neck articulate with one another by means of slightly concave surfaces (instead of by ball-and-socket joints), such a curvature was apparently impossible.

OF UNCERTAIN POSITION.

Group PLACODONTIA (*extinct*).

(Case 5.)

In this place may be mentioned the extinct Triassic reptiles known as *Placodus* and *Cyamodus* (**51**), mainly represented by their skulls. These skulls are characterised by their broad and flattened shape, and by the presence on the palate of a small number of bean-like teeth, evidently adapted for crushing hard substances; in addition to which there are two or three pairs of chisel-like teeth in the front of the jaws. The systematic position of these reptiles is still a matter of uncertainty. The cast of a fine skull of *Cyamodus* is exhibited.

Order X.—THEROMORPHA (Mammal-like Reptiles—*extinct*).

(Case 5.)

The members of this extinct group are confined to the Permian and Triassic epochs, and are abundant in South Africa and Russia. They are connected on the one hand with the Stegosaurian Amphibia, and on the other with the Monotreme Mammalia, to the latter of which they exhibit resemblances in the structure of the skeleton, and of which they seem to have been the ancestors. In the skull the quadrate is fixed, and there is a large parietal foramen; the pubis and ischium of each side of the pelvis meet in the middle line to form a symphysis; the shoulder-girdle consists of three bones, and the humerus has a perforation (entepicondylar) at the lower end. The two temporal arches of the skull have coalesced into one, corresponding to the cheek-arch of Mammals. The group is divided into the following sub-orders :—

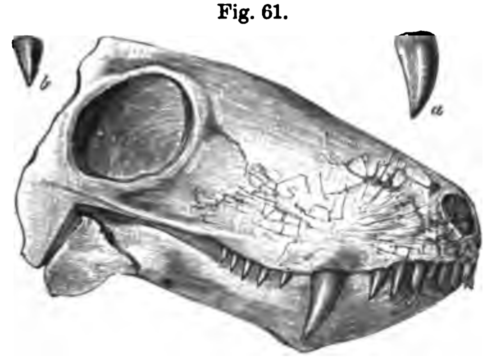
I. Pariasauria.—The skull is completely roofed over by sculptured bones, so that the only vacuities on the upper surface are formed by the nostrils, eye-sockets, and parietal foramen. The teeth are relatively small, and form an even series. *Pariasaurus* (**52**) was a large uncouth reptile, measuring nearly 8 feet in length (inclusive of the short tail) and between 2 and 3 feet in height.

II. COTYLOSAURIA.—Typically a North American group, distinguished by the roofing-over of the temporal region of the skull (sometimes with a small foramen), the presence of more than 2, 3, 3, 4, 3 joints to the toes (the number in the Pariasauria). *Procolophon* (**59**) and *Empedias* (**58**) are well-known genera, in which the cheek-teeth have transversely elongated molar-like crowns.

III. THERIODONTIA.—The temporal region of the skull shows large vacuities, and the single temporal (zygomatic) arch in some cases (*Cynognathus*, **54**) exhibits a vacuity indicative of its double origin. The teeth are typically differentiated into incisors, tusks, and a cheek-series; the lower tusks biting in front of the upper pair. *Galesaurus* (**57**) and *Cynognathus* (**54**) are typical forms. The position of *Tritylodon* (**56**), in which the teeth are of a different type, and those of the cheek-series extremely Mammal-like, is uncertain; the skull has the pre-frontal and post-frontal bones of Reptiles.

IV. DICYNODONTIA.—In this group the teeth are reduced to a pair of long permanently-growing upper tusks, or are altogether wanting; and the jaws were probably sheathed in horn. The quadrate-bone is greatly elongated, and thus forms a pedicle for the support of the lower jaw. *Dicynodon* (**63**), *Udenodon*, and *Ptychosiagum*, are well-known examples.

Fig. 61.



Right side of Skull of a Theriodont (*Ælurosaurus felinus*), two-thirds nat. size, with two upper teeth nat. size (*a*, *b*), from the Triassic Formation, Cape Colony. Behind the large socket of the eye the skull is broken away. (No. **53**.)

Casts of skulls and other parts of the skeleton of several of the more striking forms, such as the theriodonts *Cynognathus* (**54**) and *Ælurosaurus* (**53**, fig. 61), as well as *Dicynodon* (**63**) and *Pariasaurus* (**52**), are exhibited.

II.—THE AMPHIBIAN SERIES.

Class AMPHIBIA, or BATRACHIA.

(Table-Case in Middle Line of Gallery.)

As already mentioned, Frogs, Toads, Newts, and Salamanders are commonly regarded as Reptiles; but, together with certain allied creatures, they differ, as a whole, from true Reptiles by several well-marked features, and they are accordingly assigned to a separate class, the Amphibia, or Batrachia. A general feature of this class is the marked difference between the young (commonly called tadpoles) and the adults; the former living in water and breathing by external gills, while the latter are largely terrestrial and breathe by lungs. Some types, such as the Olm, are, however, permanently aquatic and gill-breathing; while in certain Frogs the transformation process is hurried through within the eggs from which full-formed Frogs emerge. In the living kinds the skin is mostly smooth, clammy, and devoid of scales. The skull articulates with the first vertebra by two knobs or condyles instead of by one, as in Reptiles. The hind-limbs (when present) are nearly always five-toed in the adult, but the front-limbs are very generally four-toed.

The following table exhibits the orders and families into which the class is divided.

Order I.—ANURA (Frogs and Toads).	I. AGLOSSA.		Family *Pipidæ*.
			" *Dactylethridæ*.
	II. PHANEROGLOSSA.	A. *Arcifera*.	" *Discoglossidæ*.
			" *Pelobatidæ*.
			" *Bufonidæ* (Toads).
			" *Hylidæ*.
			" *Cystignathidæ*.
		B. *Firmisternia*.	" *Dyscophidæ*.
			" *Engystomatidæ*.
			" *Dendrobatidæ*.
			" *Ranidæ* (Frogs).

Order II.—URODELA . . . (Salamanders and Newts.)	Family *Amphiumidæ*.
	„ *Salamandridæ*.
	„ *Proteidæ*.
	„ *Sirenidæ*.
„ III.—APODA . . . (Cœcilians.)	„ *Cæciliidæ*.
„ IV.—STEGOCEPHALA . (*Extinct.*)	„ *Labyrinthodontidæ, etc.*

Order I.—ANURA.

Frogs and Toads.

The members of this order are sufficiently characterised by the fact that in the fully adult condition the tail is completely absent,

Fig. 62.

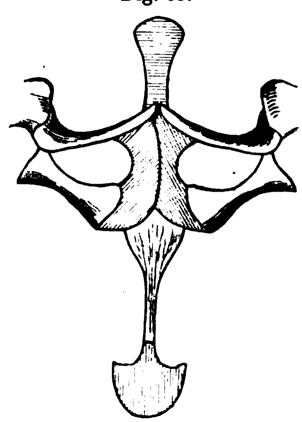
The Common Frog (*Rana temporaria*). (No. 442.)

in addition to which may, however, be mentioned the peculiar but well-known form of the body, and the more or less marked elongation of the hind limbs. In the skeleton the spinal column is very short, and terminates posteriorly in a long spine from behind the point where the pelvis is articulated to the transverse processes of the several

vertebræ. There are four front toes. Owing to the absence of ribs, Frogs, like other Amphibians, can only breathe by swallowing air.

The order is divisible into three main groups, the first of which, forming the section Firmisternia, includes the Typical Frogs, or *Ranidæ* (**480–493**), the *Dendrobatidæ* (**499–500**), *Engystomatidæ* (**494–498**), and *Dyscophidæ* (**401, 402**). All these are characterised by the presence of a tongue and by the union of the two inferior bones of the shoulder-girdle, or coracoids, in the middle line of the chest to form a firm bar. In the *Ranidæ* the transverse processes of the sacral vertebra form simple rods, and there are typically teeth only in the upper jaw, although in Günther's Frog (*Ceratobatrachus guentheri*, **490**) of the Solomon Islands, these are developed in both jaws. The *Dendrobatidæ* have both jaws toothless. The *Engystomatidæ* and *Dyscophidæ* differ by the expanded sacral transverse processes. In the former teeth are lacking in both jaws, but in the latter they are developed in the upper one, while in *Genyophrys*, which may represent a family, the lower jaw is alone toothed. Some *Ranidæ*, like *Rhacophorus* (**491**), are arboreal and have adhesive toe-pads and webbed feet, but it is untrue that they use the latter as a parachute. Certain species deposit their eggs enveloped in foam in mud or grass on the banks of ponds. Many kinds of *Rana*, like the Bull-Frog, have internal or external dilated vocal sacs. All the American *Dendrobatidæ* live in trees.

Fig. 63.



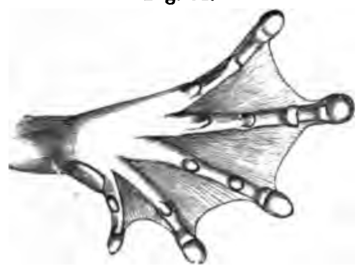
Bones of the chest of Goliath Frog (*Leptodactylus pentadactylus*) to show structure characteristic of the Toad group.

The largest representative of the group is the huge *Rana guppyi* (**483**), of the Solomon Islands; of this Frog both the mounted skin and the skeleton are shown. Another well-known, although much smaller, species of which a specimen is exhibited is the Indian Tiger-Frog, *R. tigrina* (**487**). The Common Frog (*R. temporaria*, **482**), the continental Edible Frog (*R. esculenta*, **485**), and the American Bull-Frog (*R. catesbiana*, **488**), are also shown in the case.

The Toads (*Bufonidæ*, **413–420**) may be regarded as the typical representatives of the section Arcifera, which also includes the families *Discoglossidæ* (**435–439**), *Pelobatidæ* (**440–442**), *Hylidæ*

527–534), and *Cystignathidæ* (**507–512**), and is characterised by the circumstance that the coracoid bones overlap one another on the chest instead of meeting by their edges in the middle line (fig. 63). The

Fig. 64.



Hind Foot of a Tree Frog (*Hylobates palmatus*) to show expanded tips of the toes.

Common Toad (*Bufo vulgaris*, **515**) and the great Brazilian Water-Toad (*B. marinus*, **520**) are shown. The *Cystignathidæ* differ from the other families in having the transverse processes of the sacral vertebra cylindrical, instead of expanded at the extremities. Of the

Fig. 65.

The Pouched Frog (*Nototrema marsupiatum*), with eggs in pouch. Ecuador. (No. **533**.)

four families in which these processes are expanded, the *Hylidæ* are distinguished by having claw-shaped terminal toe-bones. Of the three families without claw-shaped terminal toe-bones, the *Discoglos-*

sidæ are characterised by the presence of ribs and of teeth in the upper jaw, while the *Bufonidæ* have neither ribs nor teeth, and the *Pelobatidæ* are distinguished by the absence of ribs coupled with the presence of teeth in the upper jaw.

Of the *Discoglossidæ* common European examples are the Fire-bellied Toad (*Bombinator igneus*, **538**) and the Mid-wife Toad (*Alytes obstetricans*, **537**). The former is a poisonous species, protected by its bright "warning" colours. The males of the latter species carry the spawn coiled round their limbs, as shown by a specimen in the

Fig. 66.

The Horned Toad (*Ceratophrys cornuta*), Brazil; reduced. (No. **511**.)

case. The Claw-heeled Toad (*Pelobates fuscus*, **548**) is a familiar continental representative of the *Pelobatidæ*. Of the *Bufonidæ* there are two British species, the Common Toad (**515**) and the Natterjack (**513**); the largest species being the Brazilian Water-Toad. The *Hylidæ*, or Tree-Frogs, are brilliantly coloured arboreal forms. Some of these, like the Pouched Frog (*Nototrema marsupiatum*, **533**, fig. 65), carry their eggs in a pouch in the loins, and others adhering to the skin of the back. The *Cystignathidæ*, which may be regarded as the South American representatives of the Frogs, include the

Goliath Frog (*Leptodactylus pentadactylus*, **508**), the Horned Toad (*Ceratophrys cornuta*, fig. 66) of Brazil, and the smaller Esquerzo (*C. ornata*, **510**) of Argentina. The latter is a fierce creature, attacking and killing animals as large as rats, and uttering a bell-like note.

The members of the families *Dactylethridæ*, **543** (or *Xenopodidæ*), and *Pipidæ* differ from other Frogs and Toads by the absence of the

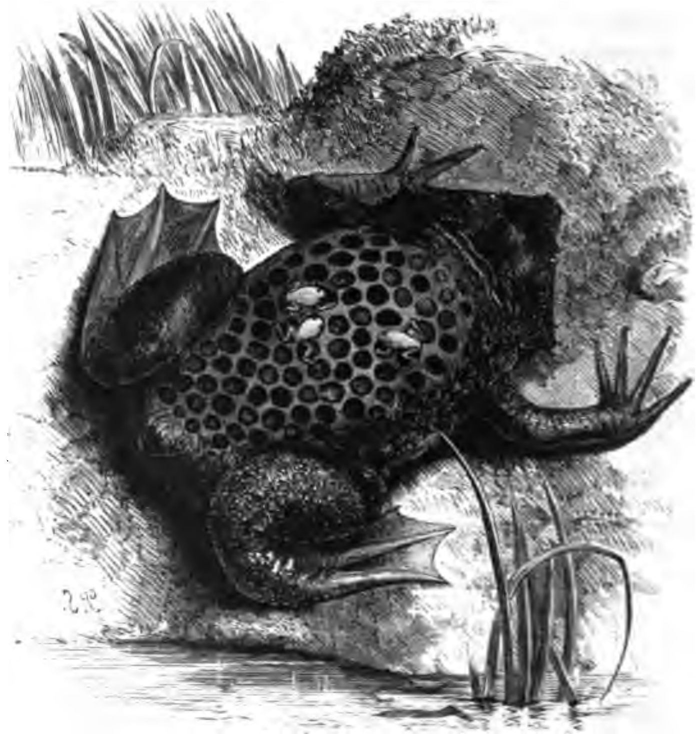
Fig. 67.

The Clawed Toad (*Xenopus lævis*), Tropical Africa. (No. **543**.)

tongue. They are consequently arranged in a sub-order (Aglossa) of equal value to a second (Phaneroglossa) which includes the sections Firmisternia and Arcifera. The Clawed Toads (*Xenopus*, **543**, fig. 67), which are the typical representatives of the family *Dactylethridæ*, have teeth in the upper jaw and sharply pointed toes, of which the front ones are free, while those on the hind-feet are united by webs. These toads are entirely aquatic. The Surinam Toad (*Pipa ameri-*

cana, **544**, fig. 68), representing the *Pipidæ*, is quite toothless, and has each front-toe terminating in a kind of star; the fore-toes being free and the hind-ones webbed. The shape of this Toad is very peculiar, the head being depressed and triangular, and the eyes minute. In both sexes the skin is covered with tubercles; and in the breeding

Fig. 68.



A Female Surinam Toad (*Pipa americana*) with young emerging from the brooding pouches of the back. (No. **544**.)

season the skin of the back of the female assumes a spongy structure and forms pouches for the reception of the eggs, which are put in position by the male. Eventually each egg becomes completely concealed in its pouch, which is furnished with a lid; and in these pouches the young undergo their development, until they make their appearance as fully-formed Toads. In habits the Surinam Toad is completely aquatic.

Order II.—URODELA.

Salamanders and Newts.

The members of this group, which are chiefly confined to the more northern countries of the Northern Hemisphere, are characterised by the possession in the adult state of a tail and at least the front pair of limbs, whence they are termed Tailed Amphibians. Of the four families, the *Amphiumidæ* and *Salamandridæ* have maxillary bones in the skull; the second of these families differing from the first by the presence of movable eyelids. The *Proteidæ* are distinguished from both the above by the absence of maxillæ, and the permanent retention of external gills; while the *Sirenidæ*, in which the gills are also persistent, differ from all the rest by the lack of hind-limbs. The larvæ are always aquatic, but the adults may be terrestrial. Occasionally, as in the Axolotls of Mexico, the larval condition is permanent, although the reproductive functions become fully developed.

Fig. 69.

The Three-toed Salamander (*Amphiuma means*). (No. **550**.)

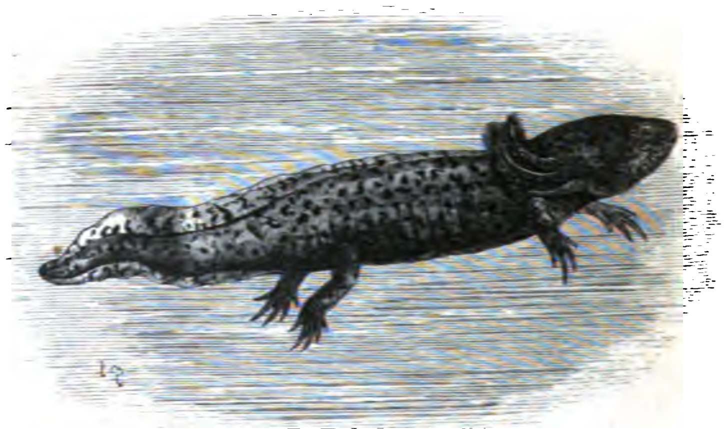
Among the members of the *Amphiumidæ*, mention may first be made of the Giant Salamanders, a group which now contains only two species, the North American "Hellbender" (*Cryptobranchus alleghaniensis*, **549**) and the Giant Salamander of Japan and China (*Megalobatrachus maximus*, **548**), the latter of which grows to a length of 5 feet, and differs from the former by the absence of a gill-opening. It is solely on this difference that the two species are assigned to genera apart. A third species occurs in the Miocene Tertiary strata of Europe. Both the living forms are carnivorous. The Japanese species lives

in small mountain-streams, where it lies concealed under stones, etc., and feeds on fishes, amphibians, worms, and insects. Like its American relative, it will readily take a bait, and it is caught for food by the natives. It does not appear ever to leave the water. A specimen has lived in captivity for over 50 years.

The typical representative of the family is the eel-like Three-toed Salamander (*Amphiuma means*, **550**, fig. 69) of North America.

Passing on to the family *Salamandridæ*, of which the distinctive features are mentioned on page 69, we have the North American Tiger-Salamander (*Amblystoma tigrinum*, **552**) as the typical representative of the sub-family *Amblystomatinæ*, which includes seven

Fig. 70.

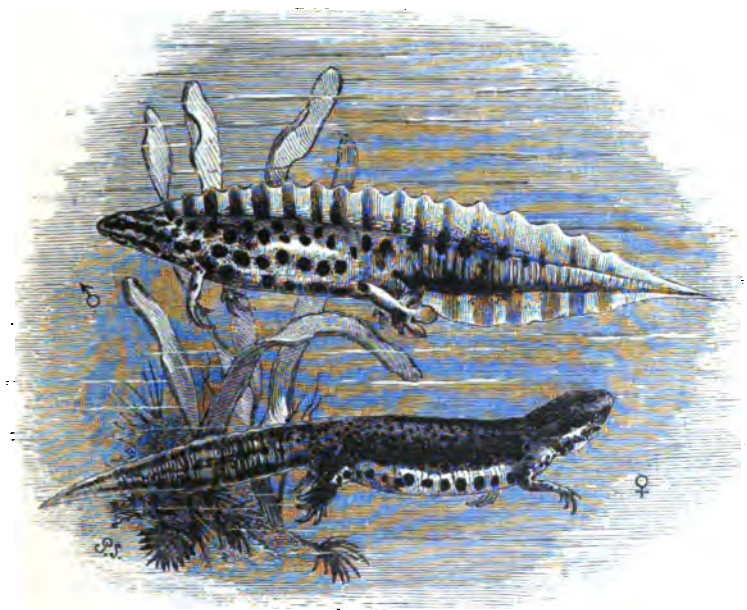


The Axolotl; the egg-laying larval form of *Amblystoma tigrinum*, Mexico. (No. **552**.)

genera, characterised by the grouping of the palatal teeth and the number (four or five) of hind-toes. Ordinarily *A. tigrinum* undergoes the usual development and transformations, commencing life as an aquatic creature with external gills, and passing when adult into a terrestrial air-breathing Salamander. In the lakes near the city of Mexico the species remains, however, permanently in the aquatic gill-bearing condition (fig. 70), reproducing its kind while in this state. To the natives these permanent larvæ are known by the name of Axolotl. They are frequently brought to this country and reproduce in the gill-bearing phase, but occasionally, even in captivity, have been seen to leave the water and change into gill-less Salamanders.

The Spotted Salamander is the type of a sub-family (*Salamandrinæ*) distinguished from the *Amblystomatinæ* by the palatal teeth forming a double series diverging behind. In the true Salamanders these teeth form a pair of Ss, while in the Newts they are ʌ-shaped, as a rule. Of *Salamandra* there are three species, the Spotted (*S. maculosa*, **561**), the Alpine (*S. atra*, **562**), and the Caucasian Salamander (*S. caucasica*). They all have five hind-toes and a rounded tail. The young are aquatic, but the adults live under moss or stones.

Fig. 71.



The Common Smooth Newt (*Molge vulgaris*). Male and female.

The spotted species exudes a poisonous fluid from the skin, which, together with its peculiar colouring, has probably given rise to the legend of its being fire-proof. The young are born alive. The Newts (*Molge*, **558–560**), of which there are some eighteen species, have the tail compressed, and frequently furnished, at least during the breeding-season, with an upright fin. They frequent cool moist situations, and during the breeding-season take to the water, where the tadpoles are born; in winter, like Salamanders, they hibernate.

There are three British species. They all have five hind-toes, but in the genus *Salamandrina* these are reduced to four.

The Slimy Salamander (*Plethodon glutinosus*) is the type of a sub-family (*Plethodontinæ*) of which all the members except the Sardinian Salamander (*Spelerpes fuscus*, **554**) are American. They are characterised by the transverse arrangement of the palatal teeth, and the presence of teeth-bearing plates on the parasphenoid, or basal bone of the hinder part of the skull. In *Spelerpes* (with five hind-toes) and *Manculus* (with four) the tongue is attached only by a central stem; in the other three genera it is fixed along the whole middle line, and cannot be protruded. Of these latter, *Anăides* is peculiar in the small number and large size of its teeth; *Batrachoseps*, in addition to its slender form, differs from *Plethodon* in having four, in place of five hind-toes. Many of the species of *Spelerpes* lay their eggs under stones, in water: but those of *Anăides* are deposited in the crevices of the bark of trees, where the adult Salamanders also dwell, and the young are born in an advanced state.

Two remarkable North American Salamanders (the Mud-eel, *Siren lacertina*, **565**, fig. 73, and *Pseudobranchus striatus*) constitute a family (*Sirenidæ*) characterised by the retention of three pairs of fringed gills, the eel-like form, the absence of hind-limbs, and the short fore-limbs, which are either three- or four-toed. The eyes have no lids, but shine through the transparent skin. Curiously enough, the external gills of the young shrivel up, but are re-developed later. In the adult *Pseudobranchus* the gills are covered with skin, so as to be useless. *Siren* is found in ditches and ponds, where it burrows in the banks, but is said to occasionally leave the water. When swimming, the limbs are closely pressed to the body, movement being effected by the tail.

The typical representative of the family *Proteidæ* is the Olm (*Proteus anguinus*, **564**, fig. 72) of the subterranean waters of Carniola, Carinthia, and Dalmatia, which is carnivorous and lives in total darkness. Three pairs of fringed external gills persist throughout life; and there are three front and two hind-toes. The eyes are buried beneath the opaque skin, which turns black after long exposure to light.

The subterranean waters of Texas are the home of a very similar creature (*Typhlomolge rathbuni*), with longer limbs, of which the front pair has four and the hind pair five toes.

The ancestral type from which both the above are derived is doubtless represented by the North American Four-toed Salamander

(*Necturus maculatus*, **462**), in which the eyes are functional and each limb is four-toed. The thick stalks of the three pairs of external

Fig. 72.

Fig. 73.

Fig. 72. The Olm (*Proteus anguinus*), from the caves of Carniola. (No. **564**.)
Fig. 73._ The Mud-eel (*Siren lacertina*), from North America. (No. **565**.)

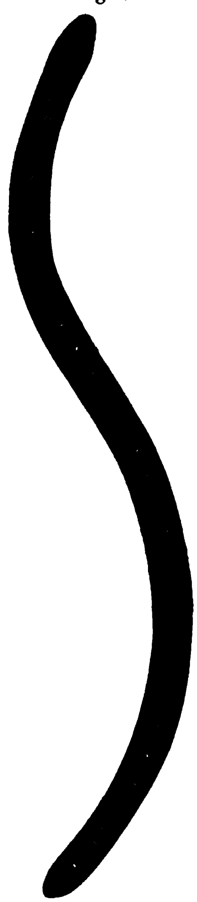
gills are brown, but the terminal fringes during life are. blood-red. A specimen is exhibited.

Order III.—APODA.

LIMBLESS AMPHIBIANS.

The few representatives of this group (often known as Cœcilians) are worm-shaped burrowing creatures (568) from Tropical America and some of the warmer parts of the Old World (fig. 74). Limbs and their supporting girdles are lacking, the tail is short, and the vertebræ, which articulate by concave surfaces, carry long ribs, none of which meet a breast-bone. The body is covered with a slimy skin, which may contain embedded scales, thrown into transverse folds or rings. The skull is solid, with much of the upper surface roofed in by bone, although this roof is not comparable with that of the Stegocephala. In some species, at any rate, the external gills are shed while in the egg, but the larva inhabits the water, although the burrowing adult is so completely terrestrial that it will drown in that element. The eggs of some Indian and African species are ranged in a cluster, round which the parent coils herself. Cœcilians feed on worms, etc. Some kinds are viviparous, and their larvæ do not enter water.

Fig. 74.



A Limbless Amphibian (*Uræotyphlus africanus*).

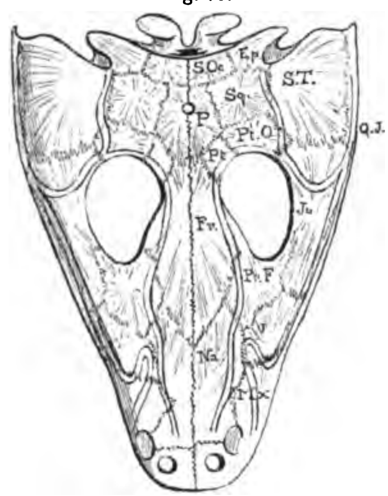
Order IV.—STEGOCEPHALA (*extinct*).

LABYRINTHODONTS.

The earliest known terrestrial four-footed creatures occur in the Carboniferous strata, and are succeeded by allied types in the Permian and Trias. They take their name of Stegocephala from the circumstance that the whole upper surface of the skull is roofed in by membrane-bones, which are frequently sculptured. The complicated internal structure of the teeth in one group has given rise to the name Labyrinthodonts, by which they are also known. Although

displaying many signs of affinity with Reptiles, they resemble Amphibia in having two condyles to the skull (when any are present), and the vertebræ are of a simple type. The chest was in many cases protected by a shield formed of three sculptured bony plates, of which the middle one appears to represent the interclavicle and the lateral pair the clavicles of other vertebrates. In form they were mostly salamander-like. The order is divided into

Fig. 75.



The Skull of a Labyrinthodont (*Mastodonsaurus giganteus*), upper view with sculpture omitted, from the Lower Keuper of Würtemberg; about one-eighth nat. size. *Ep.* lateral supratemporal: *Fr.* frontal; *Ju.* jugal; *L.* lachrymal; *Mx.* maxilla; *Na.* nasal; *P.* parietal; *Pr.f.* prefrontal; *Pt.* postfrontal; *Pt.o.* postorbital; *Q.J.* quadratojugal; *S.T.* prosquamosal; *S.Oc.* inner supratemporal; *Sq.* squamosal. The double lines indicate slime canals.

four groups: (I.) Branchiosauria, typified by the minute *Protriton*, or *Branchiosaurus* of the Permian; (II.) the snake-like Aistopoda, of the Carboniferous and Permian; (III.) Microsauria, represented by *Hylonomus* of the Carboniferous and *Hyloplesion* of the Permian, both small forms approximating to the Rhynchocephalian Reptiles; and (IV.) Labyrinthodonta, which includes the larger forms, such as *Mastodonsaurus* (fig. 75), *Loxomma* (**572**), and *Rhytidosteus* (**573**), and ranges from the Upper Carboniferous to the Trias. Other specimens exhibited are *Brachyops* (**570**) from India and *Capitosaurus* (**571**) from England.

GUIDE-BOOKS.

(*To be obtained only at the Museum.*)

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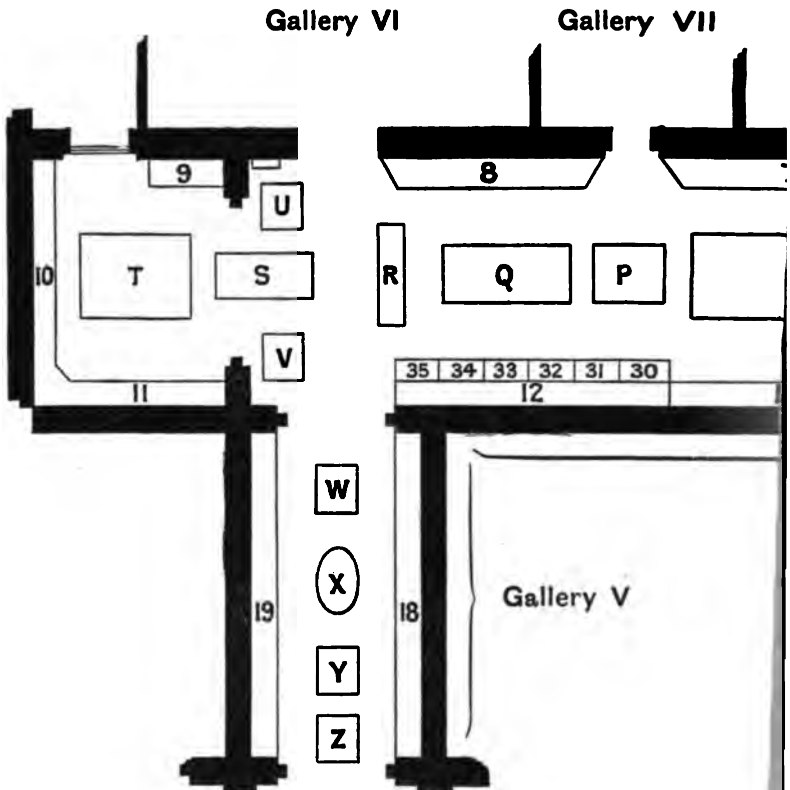

PLAN O

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8

A GUIDE

TO THE

SSIL REPTILES, AMPHIBIANS, AND FISHES

IN THE DEPARTMENT OF

GEOLOGY AND PALÆONTOLOGY

IN THE

RITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

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PREFACE.

SINCE the last edition of the "Guide to Fossil Reptiles and Fishes" was published in 1896, the additions to the collection have been so numerous, and knowledge has advanced so much, that the book has now been entirely re-written by Dr. A. Smith Woodward, the Keeper of Geology. The present issue, however, retains all the original features of the Guide, and is not in any sense a systematic treatise. Its arrangement is determined by that of the cases and specimens, and it sometimes refers to trivial details which are of interest solely to visitors actually in the Galleries.

As fossils can only be understood by those who have some acquaintance with the existing world of life, this Guide assumes on the part of the reader at least as much elementary knowledge as is contained in the Guides to the Department of Zoology.

Many of the specimens bear small discs of green or red paper. Those marked with green discs are either "type-specimens" or have been described and illustrated in some scientific work, to which a reference is given on the label. Those marked with red discs have been merely noticed or briefly described in print.

E. RAY LANKESTER,
Director.

June, 1905.

INTRODUCTION.

OBJECTS much resembling fishes, shells, plants, and other remains of living things, have been noticed in rocks from time immemorial. They are so abundant and conspicuous in some of the countries round the Mediterranean, where the Greek and Roman civilisations flourished, that they cannot fail to have attracted the attention of the earliest observers. Herodotus, for example, referred to sea-shells from the stone quarries in the hills of Egypt and the Libyan desert. Other contemporary philosophers and writers made similar observations, and most of them appear to have reached the very natural conclusion that these petrified relics were originally buried in the bed of the sea, which had hardened and become dry land through the retreat of the waters.

At this early period in the study of natural philosophy, however, it was a common belief that animals could originate from the mud or slime of lakes and rivers. There was therefore another reasonable explanation of their occurrence as petrifactions in stone which seemed simpler, because it did not involve any startling theories as to great changes in the relations of land and sea. If certain animals could be generated in mud, it appeared quite probable that they should sometimes remain concealed in their native element without reaching the surface, and in that case they would become hardened into stone itself. As Theophrastus remarked concerning petrified fishes, they might have "either developed from fresh spawn left behind in the earth, or gone astray from rivers or the sea into cavities of the earth, where they had become petrified." These bodies thus appeared to be mere curiosities, and they were treated as such by Aristotle,

who was content to regard them as produced by some plastic force in the rock which he could not explain.

The authoritative opinion of Aristotle was almost universally accepted by the few writers who considered the subject before the revival of learning towards the beginning of the sixteenth century. By this time the numerous shells, teeth, and fish-remains met with in the stone quarries of Italy had induced several observers in that country to reconsider the question of their true nature. Similar discoveries in other European countries were also being discussed in their bearing on the same problem. The objects found in stone were now closely compared with the shells, teeth, and skeletons of the animals most nearly resembling them which still lived in the Mediterranean sea. The plant-remains were also studied deeply in connection with the leaves of the known existing vegetation. The result was that, although many observers still adhered to the long-prevalent belief, some of the most philosophical minds were compelled by strict reasoning to admit that the *fossilia* (Latin, "things dug up"), or fossils, as they were now commonly termed, were really the remains of the once-living animals and plants which they appeared to represent. Leonardo da Vinci, the well known painter, was one of the first to support this opinion with unanswerable arguments; while Steno, a Professor in the University of Padua, more than a century later, made it impossible any longer to doubt his demonstration of the facts. Steno's collection was acquired by the English Gresham Professor, John Woodward, who bequeathed it to the University of Cambridge, where it is still preserved in the Woodwardian Museum.

The true nature of fossils was thus settled by the beginning of the eighteenth century, and the next problem was to explain how the remains of sea-animals had been buried in the rocks far inland and at great heights among hills and mountains. For at least sixty years it was the prevailing opinion that all the phenomena could be accounted for by the Deluge recorded in the Pentateuch. There were, however, many difficulties in accepting this explanation, and the discussions at the time led to a most detailed study of the manner in which the fossils were grouped and distributed in the different kinds of rock. Observations accumulated at a remarkable rate, until, by the end of the eighteenth century, it became quite clear that the fossilised animals and plants could not have lived all together at one

time, but belonged to many different periods of the earth's history. Their destruction and burial, therefore, could not be ascribed to any single great catastrophe. It was demonstrated that during past ages the distribution of land and sea, mountains and plains, had frequently changed—that, in fact, rain, rivers, waves, currents, volcanoes, and phenomena like earthquakes, were continually altering the earth's surface, even under the eyes of man himself. The fossils were proved in most cases to be buried in displaced portions of sea-bottom, and in the mud of dried-up lakes; and it was realised that the relative ages of these deposits could be determined by the order in which they lay one upon another. Thus arose the true "science of the earth," which was named **Geology** by De Luc in 1778.

An English civil engineer, William Smith (1769–1839), was perhaps the first to realise fully the possibilities of this new branch of learning. His profession necessitated much travel through the country, and his interest in the distribution of fossils in the different kinds of rock led him to make a large collection, which was acquired by the British Museum in 1816, and is now exhibited in Gallery No. 11 of the Department of Geology. His published maps and writings prove that the various features of the landscape, in districts where fossils occur, are naturally carved out of layers of rock, which are simply old sea-beds or lake-beds piled one upon another, the oldest at the bottom, the newest at the top, each containing its own definite and invariable set of fossils. They also show that in most cases when these old sediments were raised into dry land, they were tilted in various ways from their originally horizontal position; so that it is often possible in a short walk to pass over the cut edges of many successive layers, perhaps hundreds of feet in thickness, representing immense periods of time.

While Smith and others were busily engaged in collecting fossils and observing their distribution, Blumenbach, Cuvier, Lamarck, Brongniart, and other naturalists were occupied with a detailed study of the fossils themselves. They soon demonstrated that, while most of these petrified remains could be interpreted by comparing them with the life of the present world, a large proportion represented animals and plants no longer existing. They also observed that the older the fossils, the more strikingly different they were from any animals and plants now living. It therefore

became evident that fossils afforded a means of discovering the past history of life on the earth—of determining the gradual stages by which our present animals and plants have become what they are, and have assumed their present geographical distribution. Thus was attained the "science of ancient life," which was named **Palæontology** by H. D. de Blainville and Fischer von Waldheim in 1834.

The Department of Geology in the British Museum chiefly deals with fossils from the latter point of view, and attempts to explain the main features in the life of the Present by reference to that of the Past.

Note to the Geological Time-scale.—The names in the three columns to the left are applied only to periods of time. The names in the two columns on the right are those of actual strata deposited during the time-periods opposite which they are placed. These strata or rock-groups are only a few out of the many that might have been mentioned, and it must not be inferred that those in the European column are the precise equivalents of those next them in the British column. It is just because rock-formations in different parts of the world so rarely are equivalent, that a time-scale is needed to which each can be referred. The absolute duration of the divisions on the time-scale is a matter of pure conjecture; but their relative duration can be roughly estimated from the thickness of the rocks. An attempt is made to represent this relative duration by the diagram to the right, which is based on the thickness of the rocks in N.W. Europe.

[To be inset by this edge opposite p. xviii.]

ERAS.	E
CAINOZOIC or TERTIARY.	HOLOC
	PLEIS
	PLIOC
	MIOCE
	OLIGO
	EOCEN
MESOZOIC or SECONDARY.	CRETA
	JURAS
	TRIAS
PALÆOZOIC or PRIMARY.	PERMI
	CARBO FER
	DEVO
	SILUR
	ORDOV
	CAMBR
	PRECA

RELATIVE LENGTHS OF EPOCHS.

TERTIARY. 1,600 ft.
CRETACEOUS. 2,500 ft.
JURASSIC. 5000 ft.
TRIASSIC. 3000 ft.
PERMIAN. 1,500 ft.
CARBONIFEROUS. 12,000 ft.
DEVONIAN. 4000 ft.
SILURIAN. 7000 ft.
ORDOVICIAN. 15,000 ft.
CAMBRIAN. 12,000 ft.
PRECAMBRIAN. Extent unknown.

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A GUIDE

TO THE

FOSSIL REPTILES, AMPHIBIANS,

AND

FISHES.

GALLERIES Nos. 3, 4, 5, 11.—FOSSIL REPTILES.

REPTILES, or "creeping things," are appropriately named when the existing world alone is considered. It is true that most lizards run with great rapidity on land, while a few (such as *Draco*) glide through the air from branch to branch among trees. It is also true that some crocodiles are both good runners and expert swimmers. All these animals, however, progress with a distinctly gliding or sinuous creeping motion, and so soon as they stop the whole weight of their body rests directly on the ground. Their limb-bones are tipped with a cap of cartilage or gristle, and are not united by well-fitting joints like those of mammals or birds. Consequently, the limbs are used merely for progression or balancing, and do not serve either for habitual support of the body or for many of the other purposes to which they are adapted among the higher warm-blooded animals just mentioned.

The predecessors of these "creeping things," presumably including their ancestors, are revealed by fossils, and prove to be remarkably different from those which now survive. During the Secondary or Mesozoic Period of the earth's geological history reptiles occupied the place in the economy of Nature which has since been usurped by mammals and birds. There were land-reptiles, both great and small, with supporting

limbs as effective as those of an elephant or of an ostrich. Some of these were massive vegetable-feeders as ponderous as ground-sloths; others were slim carnivores as agile as cats; while a few were clearly adapted for hopping or jumping. There were also sea-reptiles with paddles formed solely for swimming, and some of these animals had the outward shape of dolphins or porpoises, while others were of unique proportions, and a few might have passed for the traditional sea-serpent. Moreover, there were numerous true flying reptiles with well-developed wings supported by bones of a texture and construction now peculiar to birds.

The Secondary period was, therefore, the "Age of Reptiles," just as the Tertiary period is the "Age of Mammals and Birds." Indeed, the casual observer on entering the Gallery of Fossil Reptiles may be pardoned for asking the reason why many of them are actually placed in the cold-blooded Reptilian Class and not among the warm-blooded mammals or birds. The brief explanation is, that they show a combination of peculiarities in the skeleton which is exclusively characteristic of reptiles in the existing world. Although some of the huge Dinosaurs bear an outward resemblance to mammals, they cannot be associated with those quadrupeds, because their lower jaw consists of several pieces and is hinged to the skull by a large separate bone (the "quadrate") while their ankle-joint is not at the root of the toes but between the two rows of ankle-bones. The Ichthyosaurs are not fishes, because their nose-passages and their chest-bones show that they breathed by lungs; while they are not porpoise-like mammals, because their lower jaw consists of several pieces and their cheek is covered with separate bones which encircle the peculiar "quadrate" bone. The Pterodactyls are not birds, because well-preserved fossils prove that they had no feathers, while their wings were arranged on a different pattern; and they are not flying mammals, or bats, because they exhibit the complexity of the lower jaw and its connections already mentioned as characteristic of walking and swimming reptiles.

In short, the modern snakes, lizards, crocodiles, turtles and tortoises are merely the degenerate survivors of a race which no longer occupies foremost rank. They give very little idea of the Class Reptilia as it was at its most flourishing period.

CLASS III.—REPTILIA.

ORDER I.—**SQUAMATA.**

SUB-ORDER 1.—**Ophidia.**

Table-case E.

The snakes appear to be essentially if not exclusively Tertiary reptiles, and their fossil remains are both rare and fragmentary. Fine portions of the vertebral column of sea-snakes (*Palæophis*) from the Lower Eocene (London Clay) of Sheppey are exhibited; and there are also some detached vertebræ of another large sea-snake (*Pterosphenus*), which is found with *Zeuglodon* in the Eocene both of Alabama, U.S.A., and of the Fayum, Egypt. The largest known snake is an extinct kind of python, *Gigantophis garstini*, from the Middle Eocene of the Fayum, represented by vertebræ and a portion of jaw, which seem to show that the animal attained a length of not less than 50 or 60 feet.

SUB-ORDER 2.—**Lacertilia.**

Table-case F.

Ordinary lizards are not definitely known before the Tertiary period, but a few detached jaws (*Macellodus*) from the Purbeck Beds, and teeth (*Coniasaurus*) from the Chalk, may perhaps belong to reptiles of this kind. Like those of the snakes, all their fossil remains are very fragmentary, and a typical collection is exhibited in Table-case F. Some of the early Tertiary lizards are interesting on account of their distribution. *Iguana*, for example, which is now characteristic of tropical America, is represented by fossils in the Upper Eocene of Hampshire and in the Oligocene Phosphorites of France. Among Pleistocene species, *Varanus priscus*, from the river deposits of Queensland, is noteworthy as being the largest known lizard, its length being probably not less than 6 feet.

SUB-ORDER 3.—**Dolichosauria.**

Table-case F.

During the Cretaceous period there were numerous swimming sea-reptiles, which seem to have been neither snakes nor lizards, but intermediate between these modern groups. They were of two kinds—one with a small head,

Table-case F.

rather slender neck, and lizard-like limbs—the other with a large head, short and stout neck, and well-formed paddles. The first kind is represented by small reptiles, which are named Dolichosauria (" long lizards") in allusion to their elongated shape. The backbone is indeed snake-like, and the vertebræ when found isolated have sometimes been mistaken for those of snakes. *Dolichosaurus* itself is represented in Table-case F by a fine specimen from the Chalk of Burham, Kent. There is also a nearly complete skeleton of a closely related animal, in hard limestone of the same geological age, from Lesina, Dalmatia.

SUB-ORDER 4.—**Mosasauria.**

Wall-case 1.

The second group of Cretaceous swimming reptiles just mentioned comprises large animals, shaped more or less like elongated porpoises or ichthyosaurs. Their skull resembles that of a lizard, but the jaws are as loose as those of snakes

FIG. 1.—Jaws of *Mosasaurus camperi*, from the Upper Chalk of Maastricht, Holland; about one-fifteenth nat. size. (Wall-case 1.)

for swallowing bulky prey, while some of the palate-bones bear recurved teeth. The teeth themselves are large and conical, and firmly fixed by swollen bases to the supporting jaws (Fig. 1). The eye is surrounded by a ring of "sclerotic plates." The vertebræ are united by shallow ball-and-socket joints, the ball being posterior. Both pairs of limbs and their supports are fundamentally like those of a lizard, but modified into effective paddles (Fig. 2). The toes are flattened from

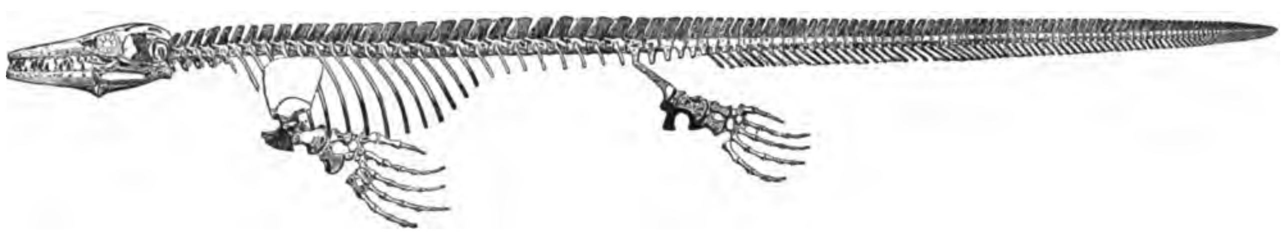


FIG. 2.—Skeleton of a Mosasaurian (*Platecarpus coryphæus*), from the Upper Cretaceous of Kansas, U.S.A.; about one twenty-fifth nat. size. (After S. W. Williston.)

Wall-case 1. side to side, lengthened by a multiplication of the joints, and destitute of claws. There is no armour, except perhaps a partial covering of thin scales. The typical genus is *Mosasaurus* ("Meuse-lizard") itself, so named because it was first found in the Chalk of Maastricht in the valley of the Meuse. This is represented in Wall-case 1, not only by a plaster cast of the skull and jaws of *M. camperi*, now in the Paris Museum (Fig. 1), originally described by Cuvier, but also by numerous other remains of the same species from Maastricht, including a fine piece of jaw presented more than a century ago by Dr. Peter Camper, the celebrated Dutch anatomist. *Mosasaurus camperi* must have been a very large animal, probably not less than 50 feet in length. Teeth and other fragments of *Mosasaurus* and allied genera (*Liodon*, etc.) are also exhibited from the English Chalk. Instructive portions of the skeleton of a smaller Mosasaurian, *Platecarpus* (Fig. 2), are shown in slabs of Chalk from Kansas, U.S.A. A hind paddle of *Tylosaurus*, from the same formation and locality, illustrates the nature of the Mosasaurian limb. There is also from the Kansas Chalk a skull of *Clidastes*, a relatively small animal shaped remarkably like a snake, but with the usual paddles, and with a deepening of the spines of the hindmost tail-vertebræ, which suggests that it was originally provided with a vertical tail-fin. Fragments of jaws of a large *Liodon* from the Greensand of New Zealand indicate the wide range of the Mosasaurians in the Cretaceous sea.

ORDER II.—ORNITHOSAURIA.

Wall-case 2. Table-cases 1-4. D. True flying reptiles lived throughout the Secondary period, and are known by many nearly complete skeletons from the Lias of England and Germany, the Lithographic Stone (Kimmeridgian) of Germany, and the Chalk of Kansas, U.S.A. They form the Order Ornithosauria ("bird-lizards"), or Pterosauria ("wing-lizards"), and are commonly referred to as Pterodactyls, because Cuvier gave the name of *Pterodactylus* ("wing-finger") to the first specimens when he originally described them and recognised their true nature. In these reptiles the skeleton is very light, and composed of hard, dense bone like that of birds of flight; while the vertebræ and limb-bones have well-fitting joints, and are hollowed to receive air from the lungs. The head is shaped like that of a bird, and similarly fixed at right angles to the neck. The brain is comparatively small, but in the arrange-

ment of its parts it bears a most striking resemblance to the brain of a bird. The neck is stout and mobile, its large vertebræ being united by ball-and-socket joints, in which the ball is posterior. The body is relatively small, and the tail varies in extent, being sometimes long and slender, sometimes very short. The wings are disproportionately large, and the wing-membrane is supported by the much-elongated fifth finger, while the other fingers remain small or even rudimentary. The breast-bone is expanded as in birds, and keeled in front to accommodate the muscles for flapping the wings. The hind limbs are weak, and four of the slender toes bear claws. No armour of any kind has been noticed even in the finest known specimens from the Lithographic Stone of Bavaria, which exhibit clear impressions of the smooth wing membrane.

Wall-case 2. Table-cases 1–4. D.

The latest Pterodactyls are the largest, and are best

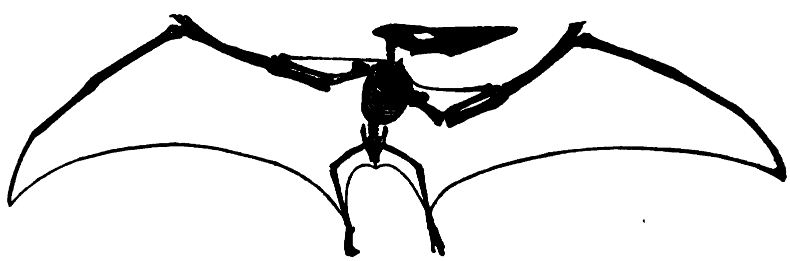


FIG. 3.—Skeleton of a toothless Flying Reptile (*Pteranodon occidentalis*), from the Upper Cretaceous of Kansas, U.S.A.; about one fifty-fourth nat. size. (Wall-case 2.)

known by skeletons from the Chalk of Kansas. They are well illustrated by a fine pair of wings of *Pteranodon*, which are mounted on a picture of the complete skeleton in Wall-case 2 (Fig. 3). The outlines and proportions of the bones painted in this picture are based partly on specimens in American museums, partly on imperfect remains in Table-cases 3, 4. The jaws form a sharp, toothless beak, and the head rises behind into a prominent crest. The breast-bone is short and broad, with the keel in front; and the shoulder-blade on each side is firmly fixed to the backbone to strengthen the socket in which the wing works. The wing-fingers, of which the actual bones are shown, are immense, and the supposed extent of the membrane they originally supported is indicated by colour. The total expanse of the wings is about eighteen feet, and it is thought that the

[Wall-case 2. Table-cases 1-4. D.] principal muscles which raised them upwards had their origin in the crest at the back of the head. Three diminutive fingers with conspicuous claws occur as mere splints grafted on the basal piece of each wing-finger. The hind legs are shown to be quite weak, and could scarcely have sup-

FIG. 4.—Skeleton of a short-tailed Flying Reptile (*Pterodactylus spectabilis*), from the Upper Jurassic (Lithographic Stone) of Eichstätt, Bavaria: nat. size. *a*. pubic bone. (Table-case 1.)

ported the whole weight of the animal when at rest or moving on the ground. The remains of *Pteranodon* in Table-case 4 exhibit the hind legs in association with the wings and the nearly complete breast-bone. All the specimens from the Kansas Chalk are flattened in the rock and broken by pressure; but a few bones of similar gigantic Pterodactyls from

the English Chalk have their central cavity filled with rock, and so preserve their original shape. An incomplete humerus from the Chalk of Burham, Kent, in Table-case 3 is especially noteworthy in this respect: where sharply cut across in three places it displays the extreme thinness of the dense bony wall, and also exhibits traces of an internal framework of delicate struts to strengthen the expanded upper end. Most of the English Cretaceous Pterodactyls (*Ornithocheirus*) were provided with large teeth in sockets, as shown by portions of jaws from both the Chalk and the Cambridge Greensand. Some of their American contemporaries were also toothed. **Wall-case, 2. Table-cases 1-4. D.**

The Jurassic Pterodactyls are much smaller than those which followed them in the Cretaceous period. Some of the

Fig. 5.—Restoration of a long-tailed Flying Reptile (*Rhamphorhynchus phyllurus*), from the Upper Jurassic (Lithographic Stone) of Eichstätt, Bavaria; one-seventh nat. size. (After O. C. Marsh.)

short-tailed forms (*Pterodactylus*, Fig. 4), exhibited in Table-case 1, are, indeed, no larger than sparrows or thrushes. All are provided with teeth in sockets, and all have three complete fingers with claws adjoining the base of the wing-finger. Their first finger, or thumb, is commonly supposed to be reduced to the little spur of bone which turns inwards to support the piece of membrane originally extending from the shoulder to the wrist. A long-tailed form (*Rhamphorhynchus*), with the slender-toothed jaws ending in front in a pointed toothless beak, is represented at the bottom of Wall-case 2 by several portions of skeletons from the Lithographic Stone of Bavaria. The grain of this stone is so fine that some specimens of *Rhamphorhynchus* have been found displaying impressions of the smooth wing-membrane. A

Wall-case 2. Table-cases 1-4. D.

plaster cast of the best of these fossils, now in the Yale University Museum, is exhibited, and justifies the late Professor Marsh's restoration of the animal reproduced in Fig. 5. It will be noted that there is a rudder-like expansion of the skin at the end of the long tail. Another long-tailed Pterodactyl (*Dimorphodon*) is also represented by some well-preserved portions of skeletons in slabs of Lias from Lyme Regis, Dorsetshire. Its head is disproportionately large and of remarkably light structure, with large teeth in sockets in front, small teeth behind. Its hind limbs are also relatively large and stout; and its long tail is strengthened by bony tendons. A plaster cast of the skull of another Pterodactyl (*Scaphognathus purdoni*), from the Upper Lias of Whitby, is noteworthy as displaying the shape and proportions of the brain (Table-case 1).

ORDER III.—CROCODILIA.

Wall-cases 1-3. Table-cases 5-12.

At the present day crocodiles live only in tropical and sub-tropical regions; but in the early part of the Tertiary period they had a much wider distribution, perhaps in consequence of the greater extent of genial conditions at that time. There cannot be much doubt, for example, that during the Eocene period the climate in the latitude of southern England was sub-tropical. True crocodiles lived in the rivers at the mouth of which the London Clay was deposited; and skulls of *Crocodilus spenceri* are exhibited from this formation near Sheerness in the Isle of Sheppey (Table-case 6, Wall-case 2A). Alligators (*Diplocynodon*), closely related to those now existing in tropical America, are also represented by fine skulls and numerous other remains from the Upper Eocene sands of Hordwell Cliff, Hampshire; while the same animals are proved by numerous fragmentary specimens to have survived in France and southern Germany until the beginning of the Miocene period. Even the long-snouted gavial (*Gavialis*), at present confined to the Indian region, seems to be represented by a portion of a jaw from the Middle Eocene of Bracklesham Bay, Sussex (Table-case 5); and one large skull from the Miocene of Austria, of which a plaster cast is exhibited in Wall-case 3, is essentially identical with the skull of *Tomistoma*, which now survives only in the Malay Peninsula and Archipelago. In warm countries where crocodiles still live, they were much more numerous and varied in former times than at the present day. There

are, for example, several skulls and jaws of extinct kinds from the Eocene of Egypt; while a large collection from the Pliocene Siwalik formation of India includes, among other interesting specimens, the snout of a colossal extinct gavial, *Rhamphosuchus crassidens*, which must have attained a length of about 50 feet (Wall-case 1). **Wall-cases 1–3. Table-cases 5–12.**

The typical modern crocodiles (Eusuchia or "perfect crocodiles") are peculiar in having their throat so constructed **Wall-cases. 2a, 3. Table-cases 5–7.**

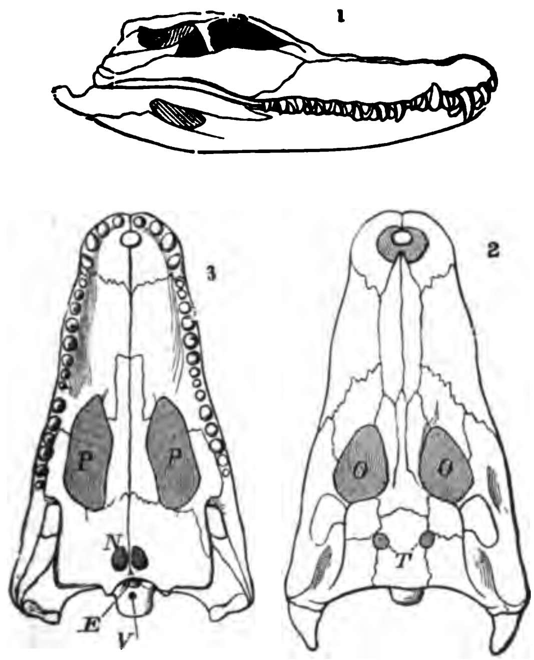


FIG. 6.—**Skull of *Crocodilus palustris*, a species living in Western India and found fossil in the Pleistocene of the Narbada Valley. 1. Right side view. 2. Upper view. 3. Palate. All much reduced in size. *E*, opening of median eustachian canal; *N*, posterior nares; *O*, orbits; *P*, palato-pterygoid vacuities; *T*, supratemporal fossæ; *V*, basioccipital bone.**

that they can keep their mouth open under water while drowning prey: they are also characterised by vertebræ united by ball-and-socket joints. A few Upper Cretaceous crocodiles agree with them in these features, a skull of *Thoracosaurus* from the Greensand of New Jersey (plaster cast in Wall-case 3) showing the characteristic palate, while vertebræ from the Chalk of France and the Cambridge

Wall-cases 2a, 3. Table-cases 5–7.

Greensand are of the typical concavo-convex pattern. All the Lower Cretaceous and Jurassic crocodiles, however, differ from those of more modern times in having the curious bony roof of the palate extending less far backwards, so that unless a soft piece of palate in their case was adapted to serve the same purpose as a plate of bone in the living crocodiles, they could not have kept their mouth open under water (compare Figs. 6 and 9). Their vertebræ were also more or less concave at both ends, not united by ball-and-socket joints; and their whole skeleton in most cases suggests a more exclusively aquatic mode of life than that of the existing crocodiles. In fact, the only Mesosuchia ("intermediate crocodiles")—as these reptiles are technically termed—which have

Wall-case 3. Table-case 8.

the outward appearance of modern crocodiles and alligators, are a few obvious marsh-dwellers from the Wealden and Purbeck formations. *Goniopholis*, with its broad head and powerful teeth, may well have preyed on land-animals which came to drink the water it haunted; while the dwarf

Table-cases 9, 10.

Theriosuchus and *Nannosuchus* are associated in the Purbeck Beds with numerous small land-mammals which would form most suitable food. All these marsh-dwellers were well armoured above and below with the usual thick, pitted, bony scutes, of which those on the back were firmly united by peg-and-socket joints as in the scales of ganoid fishes. Many of these scutes are exhibited in the collection, and they are well displayed on the slab of Purbeck stone containing *Goniopholis* (Wall-case 3), which was originally in Dr. Mantell's collection and excited much interest in 1839 when he described it under the name of "the Swanage Crocodile."

Wall-case 3. Table-case 11.

The extreme adaptation of a crocodile for life in the sea is shown by *Geosaurus* and *Metriorhynchus* (Fig. 7) from European Upper Jurassic rocks. These reptiles have the usual elongated snout of an aquatic animal, with rather large laterally compressed teeth in sockets; but the external bones of the head are not much sculptured, some, indeed, being quite smooth. Their backbone turns sharply downwards at the end of the tail, and must originally have borne a vertical triangular tail-fin, like that of *Ichthyosaurus*. Their fore limbs are very small and in the form of paddles or flippers while their hind limbs are crocodilian in shape, but relatively large for hard swimming. Bony plates are absent, so that the skin must have been as smooth as that of an Ichthyosaur or porpoise. The original skull and other bones of *Geosaurus*

from the Lithographic Stone of Monheim, Bavaria, described by Sömmerring in 1816 as the remains of a gigantic lizard (*Lacerta gigantea*), are exhibited in Wall-case 3. Fine examples of *Metriorhynchus*, obtained from the Oxford Clay **Wall-case 3. Table-case 11.**

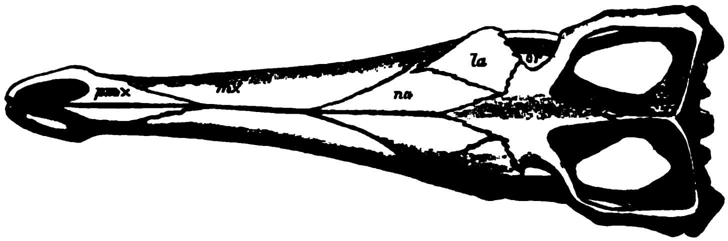


FIG. 7.—Upper view of skull of a marine Crocodile (*Metriorhynchus hastifer*), from the Kimmeridge Clay of Normandy; one-sixth nat. size. *fr.* frontal; *la.* lachrymal; *mx.* maxilla; *na.* nasal; *or.* orbit; *pmx.* premaxilla. (Allied species in Wall-case 3.)

FIG. 8.—Tooth of *Dakosaurus maximus*, from the Kimmeridge Clay of Ely; nat. size. (Table-case 11.)

of Peterborough by Mr. Alfred Leeds, are also shown in the same case.

Some contemporary crocodiles, such as the slender *Steneosaurus* and the heavy *Dakosaurus* (Fig. 8), are well armoured

Wall-case 3. Table-cases 11, 12.

both above and below, but must also have been essentially marine animals. The Lower Jurassic crocodiles (*Teleosaurus*, *Pelagosaurus*, and *Mystriosaurus*) are similarly armoured. The scutes of the back are in one paired series, while those of the belly are smaller and polygonal, forming a plate of mosaic. *Teleosaurus* has very slender jaws with sprawling interlocking teeth, and is represented by several instructive fragments from the Great Oolite of Normandy and the

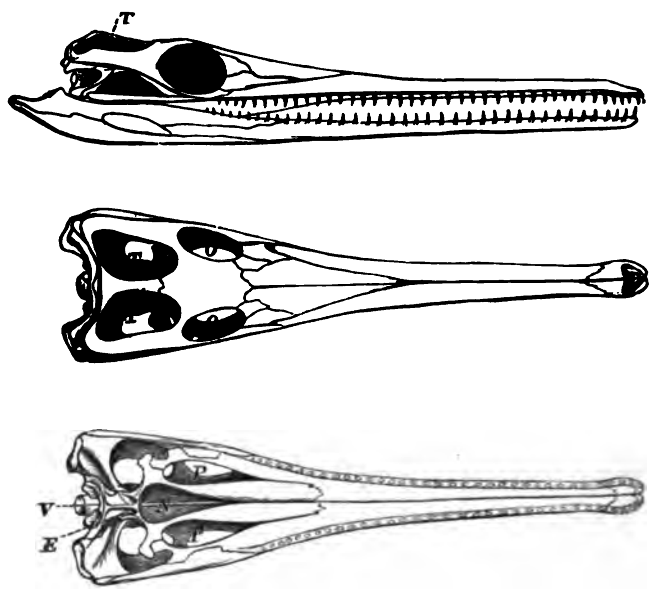


FIG. 9.—Skull of *Pelagosaurus typus*, from the Upper Lias of Normandy; one-quarter nat. size. Right side-view, upper view, and palate. *E.* opening of median eustachian canal; *N.* posterior nares; *O.* orbits; *P.* palatine vacuities; *T.* supratemporal fossæ; *V.* basioccipital bone. (After Owen. Table-case 12.)

Stonesfield Slate of England (Wall-case 3, Table-case 11). *Pelagosaurus* (Fig. 9), with equally slender jaws, is known by good skeletons from the Upper Lias of England, France, and Germany. Fragmentary remains of a small species, *P. typus*, from Normandy, in Table-case 12, are specially valuable as illustrating the chief features of its bones; and a model of a complete skeleton of the same species, exhibited in the Department of Zoology, Gallery of Reptiles, illustrates the general form and proportions of the reptile. The

incomplete skeleton of *Mystriosaurus* from Whitby, in Wall-case 3, is interesting from the fact that it is the actual specimen described as an "Alligator" by Chapman and Wooller in the Royal Society's Philosophical Transactions for 1758. Though most abundant in the Jurassic rocks of Europe, similar crocodiles seem to have been widely distributed in Jurassic seas. A head of *Steneosaurus* exhibited in Wall-case 3 was obtained from a Jurassic formation in Madagascar. **Wall-case 3. Table-cases 11, 12.**

Belodon (Fig. 10) and allied reptiles of the Triassic period have often been regarded as the primitive ancestors of the Crocodilia. The head of *Belodon*, as shown by fine specimens **Wall-case 3. Table-case 13.**

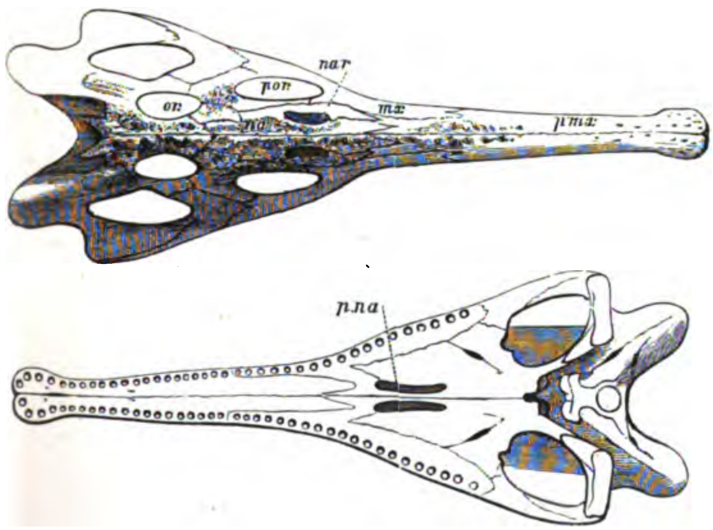


FIG. 10.—**Skull of** *Belodon kapffi*, **upper and palatal views, from the Keuper of Würtemberg; about one-eighth nat. size.** *mx.* **maxilla;** *na.* **nasal;** *nar.* **external narial opening;** *or.* **orbit;** *p.na.* **posterior nares;** *p.or.* **pre-orbital vacuity;** *pmx.* **premaxilla. (After H. von Meyer. Wall-case 3.)**

from the Upper Keuper of Würtemberg in Wall-case 3, certainly bears much resemblance to that of a long-snouted crocodile; while the back is armoured with scutes which are quite crocodilian (see also Table-case 13). The bones supporting the limbs, however, are very different from those of crocodiles, and suggest a close relationship with the contemporary Dinosauria and Rhynchocephalia. *Belodon* occurs

Wall-case 3. Table-case 13.

not only in Germany, but also in North America, while *Stagonolepis* is found in the Elgin Sandstones, Scotland (Wall-case 3).

Order IV.—**DINOSAURIA.**

Wall-cases 4–8. Table-cases 15–19. Cases I–O.

The land reptiles of the Jurassic and Cretaceous periods, with a few of their predecessors in the Trias, are usually grouped together under the name of Dinosauria ("terrible lizards"). They are most closely related to the crocodiles, but all possess well-formed limb-bones adapted for habitual support of the body on land, and some must have walked on all fours, while others can only have used their hind legs for progression. Their comparatively large tail suggests that they were ordinarily amphibious in habit and were good swimmers. Some are massive animals, and shown by their teeth to have been vegetable-feeders; while others have slender hollow bones and sabre-shaped cutting teeth, proving that they were active and fed on flesh.

Sub-order 1.—**Sauropoda.**

Wall-case 4. Table-case 15. Cases I–L.

The large and stout unarmoured herbivorous Dinosaurs, which walked on all fours, have small five-toed feet and are named Sauropoda ("lizard-footed"). As shown by discoveries of nearly complete skeletons in the Jurassic rocks of North America (Fig. 12), their head is quite small, at the end of a very long and tapering neck, while their body is short and high and ends in a remarkably elongated tail. They are the largest known four-footed animals, some of them attaining a length of 80 or 90 feet. Notwithstanding the light construction of many of their vertebræ, they must have been too heavy for much activity on land, and it seems most probable that they haunted the sea-shore, where they lived habitually in the shallow water, browsing on sea-weeds like the existing sea-cows (Sirenia). The blunt and feeble teeth would suffice for such feeding, while the long neck would enable the reptile to reach the surface of the water for breathing even when walking on the bottom at a considerable depth. A plaster cast of a partially restored skeleton of *Diplodocus carnegii*, from the Jurassic of Wyoming, U.S.A., presented by Andrew Carnegie, Esq., is mounted in the Reptile Gallery of the Zoological Department, and exhibits all the characteristic

Photograph (by Mr. J. T. Pigg) of a reproduction in plaster of a Dinosaurian Land-Reptile (*Diplodocus carnegii*), 80 feet in length, from the Upper Jurassic, Wyoming, U.S.A. (Gallery of Reptiles, Department of Zoology.)

[*To face p. 16.*

Wall-case 4. Table-case 15. Case L. are also shown; and there are placed for comparison (on black bases in the same Case) a few bones of larger species of the North American Sauropoda, *Diplodocus* and *Brontosaurus*.

Fig. 12.—Skeleton of a Sauropodous Dinosaur (*Brontosaurus excelsus*), from the Upper Jurassic of Wyoming, U.S.A.; about [illegible] nat. size. (After O. C. Marsh.)

Stand I. The femur, tibia and fibula of *Brontosaurus* (Fig. 12) from the Upper Jurassic of Wyoming are also mounted on Stand I., with plaster casts of the corresponding bones of *Cetiosaurus*

oxoniensis from the Stonesfield Slate near Oxford (the original bones being in the Oxford Museum). A plaster cast of the largest known femur or thigh-bone (*Atlantosaurus immanis*), 6 feet 2 inches in length, from Colorado, is placed on Stand J. *Ornithopsis*, from the English Wealden, is represented in Wall-case 4 by various remains from the Isle of Wight, including fine vertebræ, which display their remarkably light construction resulting from a complicated arrangement of thin **Wall-case 4. Table-case 15. Stand J.**

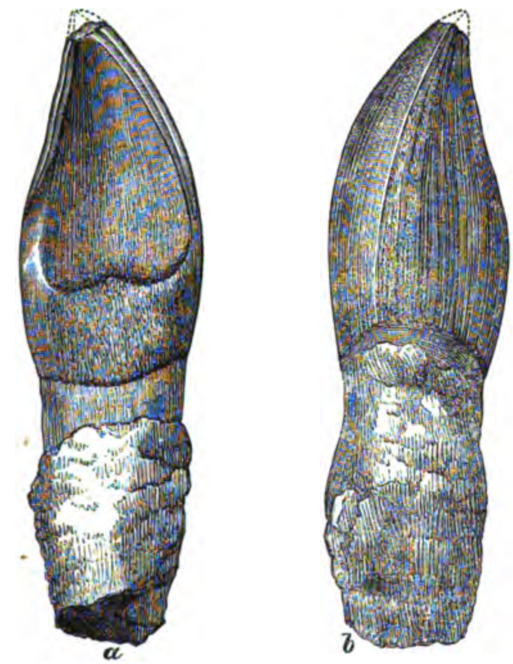


Fig. 13.—Tooth of a Sauropodous Dinosaur, probably *Ornithopsis hulkei*, from the Wealden of the Isle of Wight, inner (*a*) and outer (*b*) views; nat. size. (Table-case 15.)

struts and plates of bone. A few isolated specimens of the feeble teeth of *Cetiosaurus* and *Ornithopsis* (Fig. 13) are shown in Table-case 15. There are also some bones of allied Sauropoda from Madagascar and Patagonia in Wall-case 4.

SUB-ORDER 2.—**Stegosauria.**

Wall-cases 4, 5. Table-case 16. Case M.

The armoured Dinosaurs or Stegosauria ("plated-lizards") are shown by their teeth to have been herbivorous, and they resemble the next sub-order, Ornithopoda, so closely that they are often grouped with the latter. The latest members of the tribe, discovered in the Upper Cretaceous of Wyoming are the most heavily built, with a large horned head and a bony frill over the neck (*Triceratops* and *Sterrholophus*, Fig. 14):

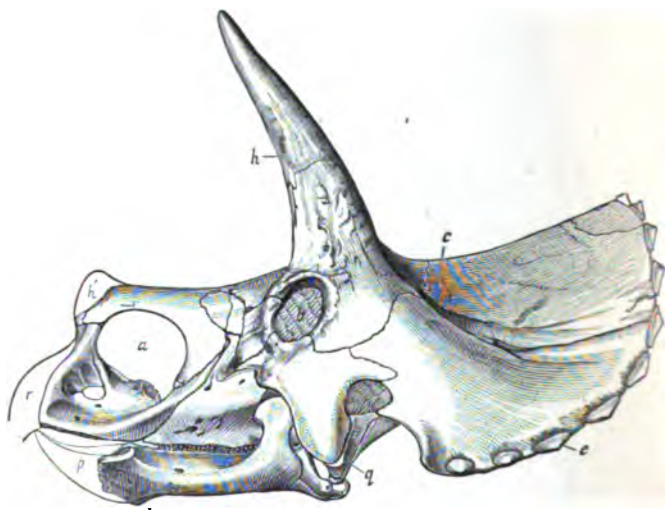


FIG. 14.—**Skull and mandible of a horned Dinosaur (*Sterrholophus flabellatus*), left lateral view, from the Cretaceous of Wyoming, U.S.A.; about one-twentieth nat. size. *a.* nostrils; *b.* orbit; *c.* supratemporal vacuity; *e.* small bony plates round the occiput; *h.* the left horn-core of the pair above the eyes; *h.'* horn-core on nose; *p.* predentary bone; *q.* quadrate bone; *r.* rostral bone. (After O. C. Marsh.)**

but there are no remains of these reptiles in the Museum. The American Jurassic *Stegosaurus*, with small head, is also well armoured with large bony plates and spines on the trunk. Its skeleton is closely similar to that of *Omosaurus*, of which fine specimens are exhibited in Wall-case 5. The hip-region and other remains of *Omosaurus armatus*, from the Kimmeridge Clay of Swindon, are especially noteworthy. In the same Wall-case there are also the original specimens of *Hylæosaurus*, obtained by Mantell from the Wealden of

Wall-case 5.

Sussex; and in Wall-case 4 there is another Wealden Stegosaurian, *Polacanthus foxi*, discovered by Rev. W. **Wall-case 4.**

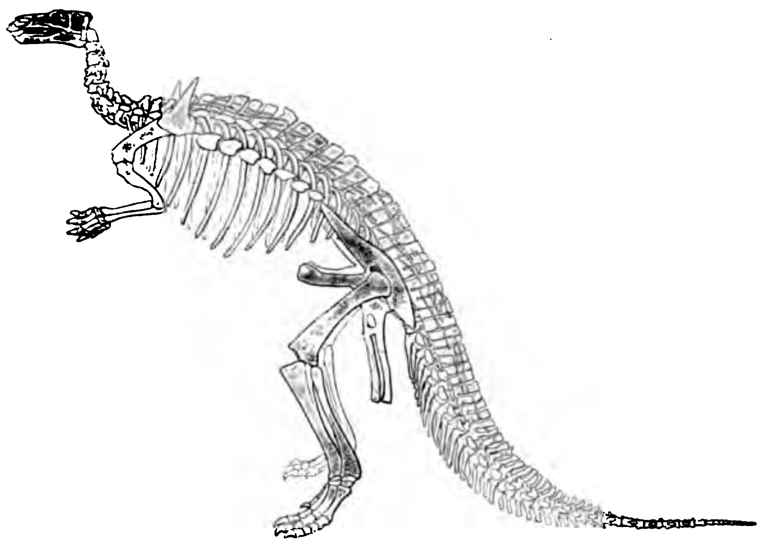


FIG. 15.—Restored skeleton of an armoured Dinosaur (*Scelidosaurus harrisoni*), from the Lower Lias of Charmouth, Dorset; about one-thirtieth nat. size. The figure shows the pair of large spines on the shoulders and a row of smaller spines behind; also the bony tendons crossing and fixing together the neural spines of the vertebræ. (Case M.)

Darwin Fox in Barnes Chine, Brixton, Isle of Wight. The latter specimen lacks the fore-quarters, but shows the paired series of sharply pointed spines on the back, a continuous bony shield over the hip-region ornamented with symmetrically arranged bosses, and another paired series of spines on the slender tail. One of the oldest Stegosauria, *Scelidosaurus harrisoni*, from the Lower Lias of Charmouth, near Lyme Regis, is represented by a nearly complete skeleton in a slab of hard rock in Case M. This reptile (Fig. 15) must have measured about 12 feet in length, and its armour is comparatively feeble. The snout of the long head is broken

FIG. 16.—A single upper tooth of *Scelidosaurus harrisoni*, from the Lower Lias of Charmouth, Dorset; twice nat. size. **Case M.**

Case M. away from the fossil exhibited, but a few of the teeth (Fig. 16) are preserved in the hinder part of the jaws. Various small fragments of Stegosauria are also placed in Table-case 16.

SUB-ORDER 3.—**Ornithopoda.**

Wall-cases 6a, 6, 7. Table-cases 17, 18. Stands N, O.

The "bird-footed" Dinosaurs, or Ornithopoda, seem to have walked habitually on their hind limbs, which bear much resemblance to those of ostrich-like running birds (Ratitae). They are well represented in the Museum by *Iguanodon* and *Hypsilophodon* from the Wealden and Lower Greensand of the south of England and neighbouring parts of the Continent.

Iguanodon ("iguana-tooth") was named in 1825 by Mantell, who first discovered its teeth (Fig. 17), and

FIG. 17.—Tooth of *Iguanodon*, outer view (A) and side view (B), from the Wealden of Sussex; nat. size. (Table-case 17.)

recognised their close similarity to those of *Iguana*, a lizard now existing in Central America. Some of the actual teeth from the Mantell Collection, exhibited in Table-case 17, show various stages of wear, from the newly-cut crowns to mere flattened stumps, and obviously denote a vegetable-feeder. The earliest-discovered group of bones of the reptile, from Bensted's Kentish Rag quarry at Maidstone, is

Wall-case 7.

placed in the centre of Wall-case 7. This specimen was shattered by a shot fired in the hole still seen in the middle of the slab of rock, and the various pieces were collected and re-united with great skill by Mantell, who tried to interpret the bones by comparison with the skeleton of *Iguana*

Subsequent discoveries, exhibited in Wall-cases 6, 6A, 7, prove that Mantell was misled in several respects, because *Iguanodon* is not in any way closely related to the existing lizards; and a few nearly complete skeletons discovered in the Wealden of Bernissart, near Mons, Belgium, now in the Brussels Museum, show all the principal features of the animal (Fig. 18). These skeletons were found at Bernissart under circumstances which suggest that the individuals they represent met their death by accident in a deep ravine. An exact plaster copy of one of them is placed on Stand O, and its height as mounted is about 14 feet, while its total length

Wall-cases 6, 6a, 7.

Stand O.

FIG. 18.—Skeleton of an Ornithopodous Dinosaur (*Iguanodon bernissartensis*), from the Wealden of Bernissart, Belgium, as mounted in the Brussels Museum: about one-eightieth nat. size. (Stand O.)

is approximately 25 feet. The large laterally-compressed head (Fig. 19) ends in front in a toothless beak, of which the lower half is supported by a separate "predentary bone." The fore limbs are comparatively small, with slender shoulder blades; and each hand comprises five fingers, though the first of these (or thumb) is reduced to a bony spur, which, when originally found isolated, was supposed by Mantell to have been a horn on the nose. The hip-bones (pelvis) much resemble those of an ostrich in arrangement, but are not fused together as in the Ratite running birds, while a great pubic bone represents a mere knob in the latter. There are

Stand O. only three toes, the basal parts of which are arranged exactly as in young running birds before the parts consolidate (see illustrations of *Dinornis* on Stand O). The tail is deep and laterally compressed, as if for swimming, and both this and the back are strengthened by partially bony tendons lying over the vertebral spines. The three-toed footprints of *Iguanodon* are not uncommon in the Wealden rocks, and are sometimes found in the Purbeck Beds. Examples are shown in Gallery No. 11 (Wall-case 8 and an adjoining stand).

FIG. 19.—Skull and mandible of *Iguanodon bernissartensis*, left side-view, from the Wealden of Bernissart, Belgium; about one-eighth nat. size. The oval nostril is seen in front, the orbit in the face above the hindermost teeth, and the deep and narrow lateral temporal fossa behind. The toothless predentary bone is shown at the front end of the mandible. (After Dollo.)

Stand N. Table-case 18. *Hypsilophodon* is a diminutive Iguanodont, of which fine portions of skeletons are exhibited in Wealden sandstone from the Isle of Wight (Stand N and Table-case 18). It has teeth in front of the upper jaw, and its hind feet are four-toed.

SUB-ORDER 4.—**Theropoda.**

Wall-case 8. Table-case 19. The Theropoda ("beast-footed") are the carnivorous Dinosaurs, with a lightly-constructed skeleton and sabre-like teeth in sockets. Most of them seem to have been shaped like *Iguanodon* and walked on their hind legs; but their hip-bones are different, and more nearly resemble those of the Sauropoda and the crocodiles. They are found in all Mesozoic rocks both in Europe and in North America (Fig.

20), and have also been discovered in South America, South Africa and India, but they are represented in the Museum **Wall-case 8. Table-case 19.**

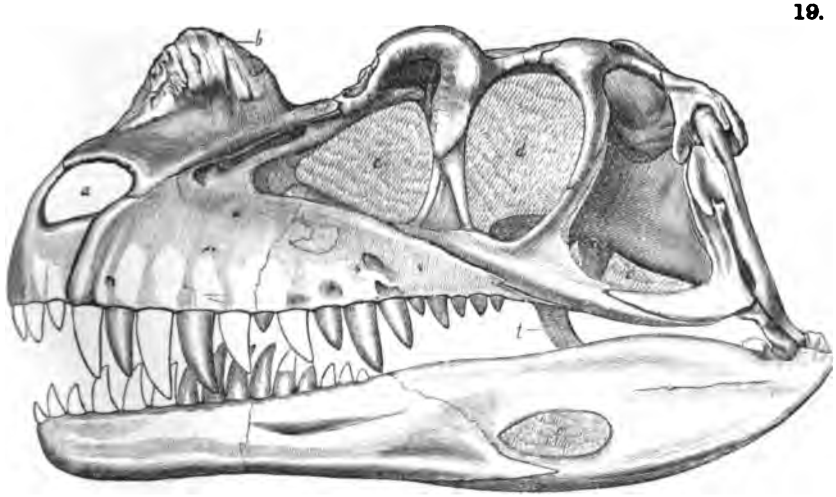


Fig. 20.—Skull and mandible of a Theropodous Dinosaur (*Ceratosaurus nasicornis*), left side-view, from the Upper Jurassic of Colorado, U.S.A.; one-sixth nat. size. *a.* nostril; *b.* horn-core on nose; *c.* preorbital vacuity; *d.* orbit; *e.* lateral temporal fossa; *f.* vacuity in mandible; *t.* transverse bone. (After O. C. Marsh.)

only by fragmentary specimens, and by a plaster cast of one nearly complete small skeleton (*Compsognathus longipes*, from the Lithographic Stone of Bavaria, in Table-case 19). Most of the remains of Theropoda from the English Jurassic and Wealden rocks are referred to *Megalosaurus*, which was first found by Buckland in the Stonesfield Slate, near Oxford (Wall-case 8 and Table-case 19). With *Megalosaurus* are exhibited fragments of *Zanclodon*, *Thecodontosaurus* (Fig. 21), and other genera from the Trias of England and the Continent, and remains of the short-necked *Euskelesaurus* from the Karoo Formation of South Africa. A small carnivorous reptile, *Ornithosuchus*, from the Triassic Sandstone of Elgin, Scotland, seems also to belong to the same group.

Fig. 21.—Tooth of *Thecodontosaurus platyodon*, from the Upper Trias of Bristol; nat. size. (Table-case 19.)

ORDER V.—RHYNCHOCEPHALIA.

Wall-case 9. Table-case 14.

The little lizard-shaped Tuatera (*Hatteria* or *Sphenodon*), now living on islands off the coast of New Zealand, is the sole survivor of an important group of reptiles which first

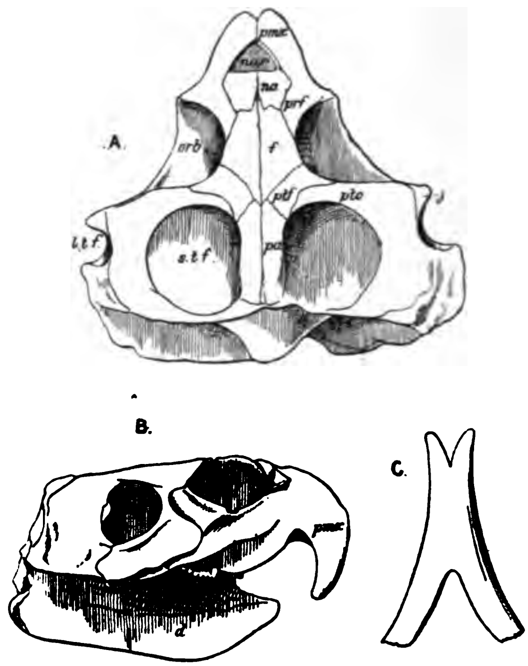


FIG. 22.—Skull and mandible of *Hyperodapedon gordoni*; upper view (A), right side-view (B), and mandibular symphysis from below (C), from the Triassic of Elgin; one-quarter nat. size. *d.* dentary; *f.* frontal; *j.* jugal; *l.t.f.* lateral temporal fossa; *na.* nasal; *nar.* nostril; *orb.* orbit; *pa.* parietal; *pmx.* premaxilla; *prf.* prefrontal; *ptf.* post-frontal; *pto.* postorbital; *s.t.f.* supratemporal fossa. (After A. S. Woodward. Wall-case 9.)

appeared in the Permian period, had a wide distribution in the Triassic period, and still existed both in Europe and North America at least as late as the deposition of the Chalk. These reptiles closely resemble some of the Triassic Theropodous Dinosauria, but their teeth are not fixed in sockets and

not confined to the edge of the jaw, while the ribs are single-headed. *Proterosaurus* occurs in the Upper Permian of Germany and England, but is only imperfectly known. *Hyperodapedon* (Fig. 22) is Triassic both in Britain and in India, and is represented in Wall-case 9 by a fine skeleton of *H. gordoni* in a slab of sandstone from Elgin, also by fragments from various other localities. *Rhynchosaurus*, from the Trias of Grinshill, Shropshire, is smaller than *Hyperodapedon* and equally well known. There is also a good skeleton of the smaller *Pleurosaurus* from the Upper Jurassic Lithographic Stone of Bavaria.

Wall-case 9. Table-case 14.

Dimetrodon and *Naosaurus*, from the Permian of Texas, U.S.A., seem to be Rhynchocephalians, and are remarkable for the length of their vertebral neural spines, which bear lateral processes (Fig. 23).

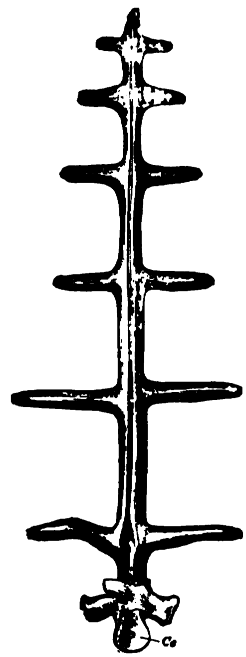


FIG. 23.—Anterior view of a dorsal vertebra of *Naosaurus claviger*, from the Permian of Texas, U.S.A.; one-sixth nat. size. *ce.* centrum or body of vertebra. (Fragments in Table-case 14.)

ORDER VI.—ANOMODONTIA or THEROMORPHA.

Wall-cases 9, 10. Table-cases 30–33.

The most characteristic reptiles of the Permian and Triassic periods are intermediate in organisation between the early Amphibia and the true Reptilia and Mammalia of later times. They are sometimes named Anomodontia ("irregular toothed"), in allusion to the varied and unusual character of their teeth, while they are sometimes described as Theromorpha ("beast-shaped"), from their evident relationship to the warm-blooded mammals or "beasts." They approach mammals (i.) in the reduced size of the quadrate bone and of the adjoining bones in the lower jaw, (ii.) in the frequently well-formed single bony bar or "malar arch" over the biting

Wall-cases 9, 10. Table-cases 30-33.

muscles of the cheek, (iii.) in the shape of the shoulder-blade, (iv.) in the fusion of the hip-bones into a single innominate bone on each side, (v.) in the presence of a prominent elbow, and (vi.) in the structure of the feet. Their nearest surviving relatives are probably the degenerate Monotreme Mammalia (*Echidna* and *Ornithorhynchus*) of the Australasian region, which have blood less warm than other mammals, possess only incipient milk-glands, and lay eggs.

Numerous remains of Anomodontia have been found in South Africa, India, the European continent (especially Russia), Scotland, and North America. The principal specimens in the Museum were obtained from the Karoo Formation of South Africa, where they were first discovered by Andrew Geddes Bain.

SUB-ORDER 1.—**Theriodontia.**

Table-cases 31, 32. Case R.

The most mammal-shaped of these ancient quadrupeds are those with cutting or piercing front teeth like incisors, with enlarged corner teeth like canines, and with comparatively

FIG. 24.—Right side-view of skull and mandible of a Theriodont (*Ælurosaurus felinus*), two-thirds nat. size, with two upper teeth, nat. size (*a, b*), from the Triassic Karoo Formation of Beaufort West, Cape Colony. Behind the large orbit the back part of the skull is broken away. (After Owen. Table-case 31.)

complex side teeth like premolars and molars. These teeth are, indeed, quite mammalian in appearance (hence the name "Theriodontia" or "beast-toothed"), but they were never replaced during life in the same way as among mammals. They are especially well shown in the fine specimen of *Cynognathus crateronotus* (Case R) obtained by Professor H. G. Seeley

from the Karoo Formation of Cape Colony. The dog-shaped head of this animal is enormous compared with the size of the backbone, which is stiffened by wide overlapping ribs just in front of the hip region. There are two occipital condyles at the back of the skull for union with the backbone, as in the Amphibia and Mammalia. Most of the limb-bones of the fossil have been lost. *Cynognathus*, *Lycosaurus*, *Ælurosaurus* (Fig. 24), and certain other genera (Table-case 31) were doubtless carnivorous; but *Tritylodon* **Table-cases 31, 32. Case R.**

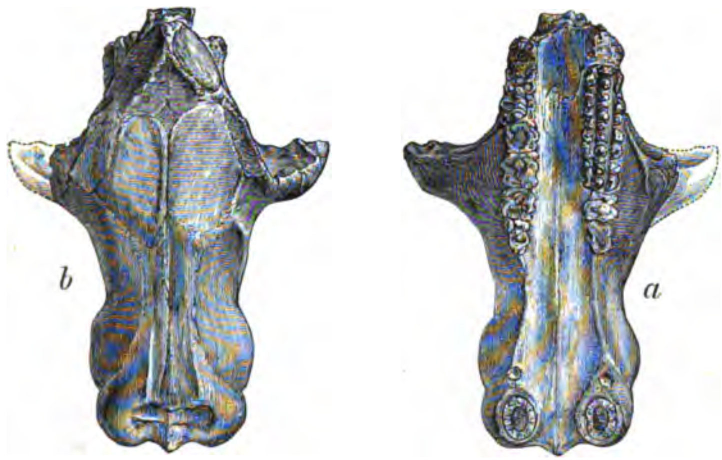


Fig. 25.—Skull of *Tritylodon longævus*, palatal view (*a*) and upper view (*b*), incomplete behind, from the Triassic Karoo Formation of Basutoland; two-thirds nat. size. (Table-case 32.)

(Fig. 25) and its allies (Table-case 32) have grinding teeth as if for a vegetable diet. The remarkably mammalian fore-limb named *Theriodesmus phylarchus* (Table-case 32) belongs to one of the Theriodonts.

Sub-order 2.—**Dicynodontia.**

The Dicynodonts ("double-dog-toothed") have a beak like that of a turtle, but most of them are also provided with a pair of tusks, growing throughout life, at the side of the upper jaw. Their occipital condyle is trefoil-shaped, as in the Chelonia. *Dicynodon* (Fig. 26) occurs in the Karoo Formation of South Africa, and is represented by fine skulls and other remains **Wall-cases 9, 10. Table-case 33.**

Wall-cases 9, 10. Table-case 33. in Wall-case 10 and Table-case 33. *Oudenodon* is a contemporary reptile without tusks. *Gordonia* (Wall-case 9), from the Trias of Elgin, Scotland, has diminutive tusks.

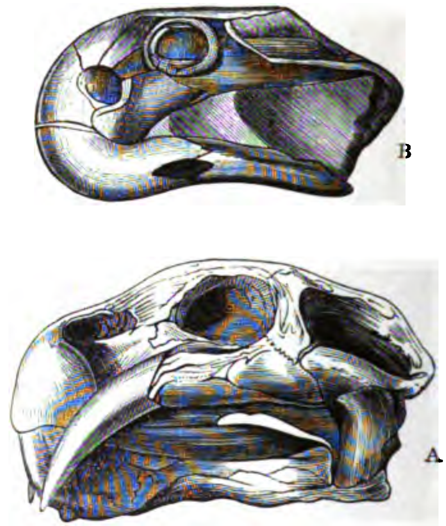
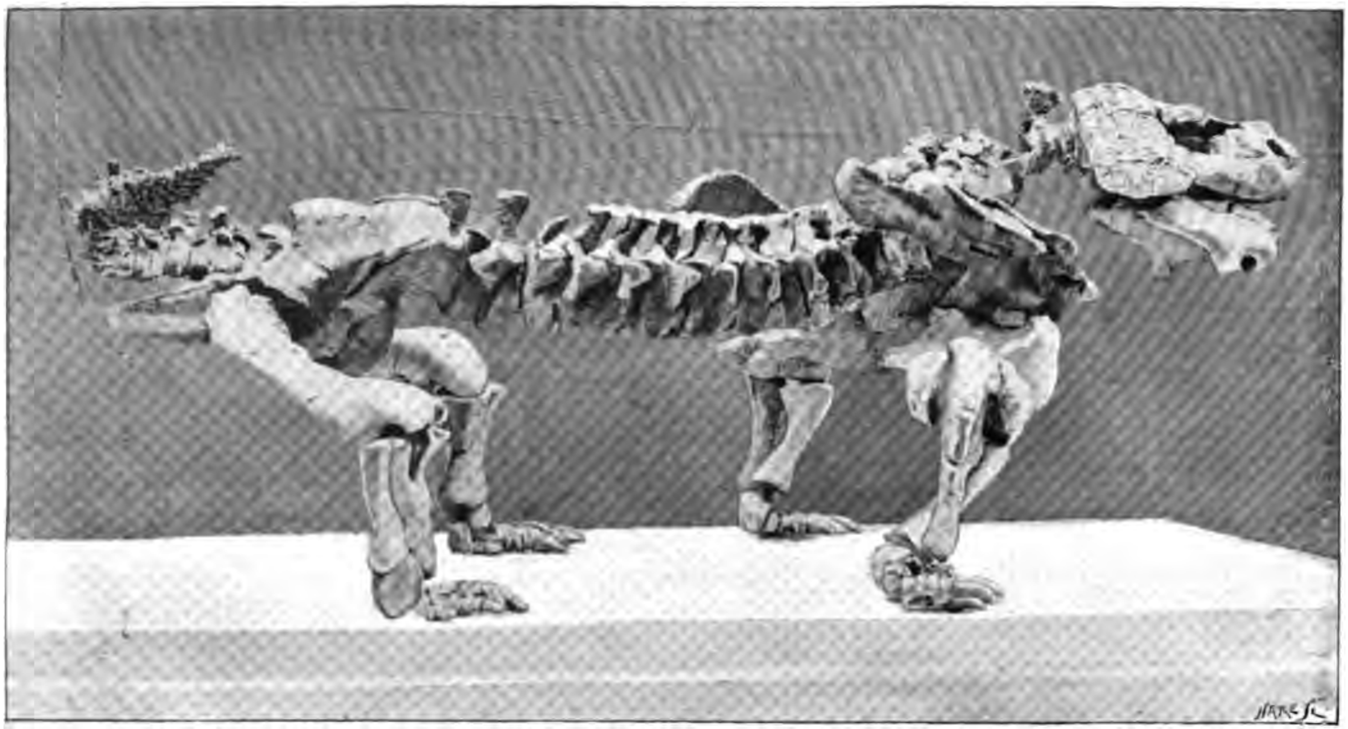


FIG. 26.—Skull and mandible of *Dicynodon lacerticeps* (A) and *Oudenodon baini* (B), left side-view, from the Triassic Karoo Formation of Cape Colony; one-third nat. size. (Table-case 33.)

SUB-ORDER 3.—**Pariasauria.**

Wall-cases 9, 10. Cases S, T. The Pariasauria are so named from the best-known genus *Pariasaurus* ("helmet-cheek-lizard"), and approach the early Amphibia or Labyrinthodonts more closely than any of the other Anomodontia. The well-preserved skeleton of *Pariasaurus baini* (Plate IV.), discovered by Professor Seeley in the Karoo Formation of Cape Colony, exhibits most of the principal characters of the skeleton (Case T). Other portions of *Pariasaurus* in Case S are also important. The cheek is completely covered with bone, and the pineal foramen for a median eye in the top of the head is especially large. There is only a single occipital condyle. The teeth extend from the margin of the jaw over most of the bones of the palate. Remains of the ribs show that they were single-headed. *Pariasaurus* is a very massive animal, usually from 8 to 10 feet in length, and seems to have been a vegetable-feeder,



Skeleton of an Anomodont Land-Reptile (*Pariasaurus baini*), discovered by Prof. H. G. Seeley in the Karoo Formation of Tamboer Fontein, Cape Colony; about one-fourteenth nat. size. (Case T.)

[*To face p.* 30.

with limbs almost as completely adapted for digging as those of a mole. It was first found in South Africa, but is now known by many nearly complete skeletons discovered by Professor Amalitzky in northern Russia. Its head-bones are coarsely sculptured, and the head of an apparently allied animal, *Elginia*, from the Trias of Elgin, is not only sculptured, but also armoured with large bony horns or spines (Wall-case 9). **Wall-case 9.**

A diminutive Anomodont, *Procolophon* (Table-case 30), from the Karoo Formation of Cape Colony, exhibits much resemblance to *Pariasaurus*, but may perhaps belong to another sub-order. Its head-bones are not sculptured, and its pineal foramen for the median eye is enormous. A nearly similar animal, *Aristodesmus*, has been found in the Lower Trias of Switzerland. **Table-case 30.**

SUB-ORDER 4.—**Placodontia.**

The skulls named *Placodus* and *Cyamodus* (Fig. 27), from the Muschelkalk (Middle Trias) of the European continent, **Table-case 30.**

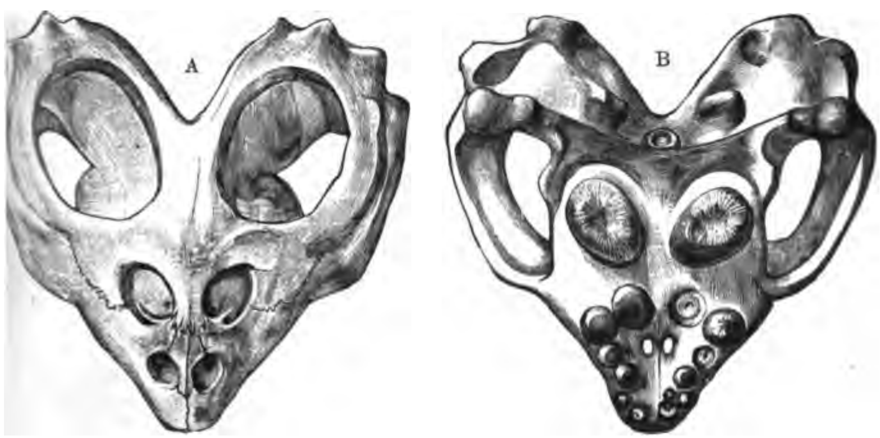


FIG. 27.—Skull of *Cyamodus laticeps*, upper view (A) and palatal view (B), from the Muschelkalk of Baireuth, Germany; one-quarter nat. size. (Table-case 30.)

are very similar in many respects to those of Anomodonts. The vertebræ and limbs of the reptiles to which they belonged are not yet known, but these parts will probably prove to be adapted for life in the sea. The teeth are large grinding

Table-case 30. plates extending over the palate, and would doubtless be used for crushing shell-fish. Good examples are exhibited in Table-case 30.

ORDER VII.—SAUROPTERYGIA.

Wall-cases 11-14. Table-cases 24-29. Cases P, Q. A group of aquatic reptiles closely related both to the extinct Anomodontia and to the surviving Chelonia was abundantly represented in all the seas of the Mesozoic period. It is known as the Order Sauropterygia ("lizard-finned") because the swimming paddles in all its representatives comprise only the usual four or five reptilian toes, which are not supplemented by other little bones as in the paddles of the contemporary Ichthyopterygia (see p. 37).

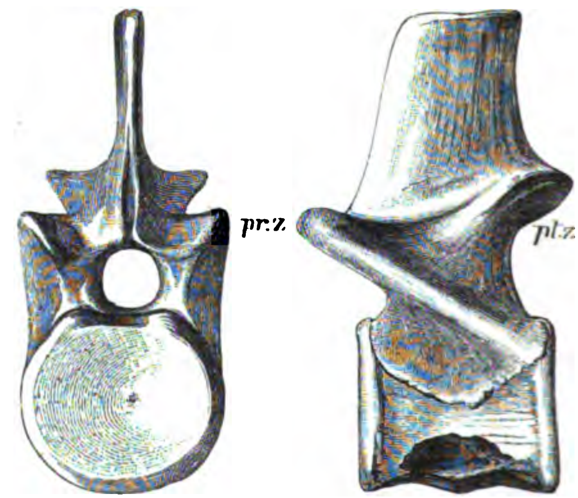


FIG. 28.—Hinder neck-vertebra of *Plesiosaurus*, front and side views, from the Lower Lias of Lyme Regis; two-thirds nat. size. *pr.z.* prezygapophysis; *pt.z.* postzygapophysis. (Table-case 27.)

Cases P, Q. The general characters of the Order are especially well shown by the skeletons of *Cryptoclidus* in Cases P, Q, while more technical points are illustrated in Table-cases 24 to 29. The head varies in size, but is usually small, and the conical teeth are fixed in deep sockets round the margin of the jaws. The vertebræ (Fig. 28) are slightly biconcave. Although the neck is always distinct and often long and slender, it must have

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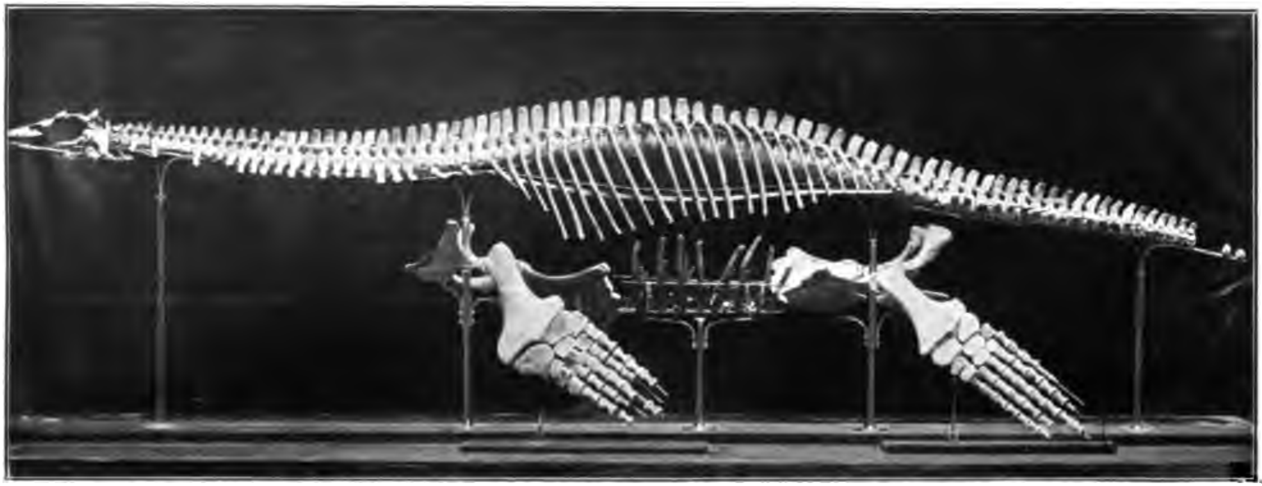


Skeleton of a Plesiosaurian Marine Reptile (*Cryptoclidus oxoniensis*), discovered by Mr. Alfred N. Leeds in the Oxford Clay near Peterborough; about one-twentieth nat. size. (Case Q.)

[To face p. 83.

been almost inflexible, and could not have assumed the graceful curves usually ascribed to it in fanciful restorations. The body is barrel-shaped, and its lower face, between the ends **Cases P, Q.**

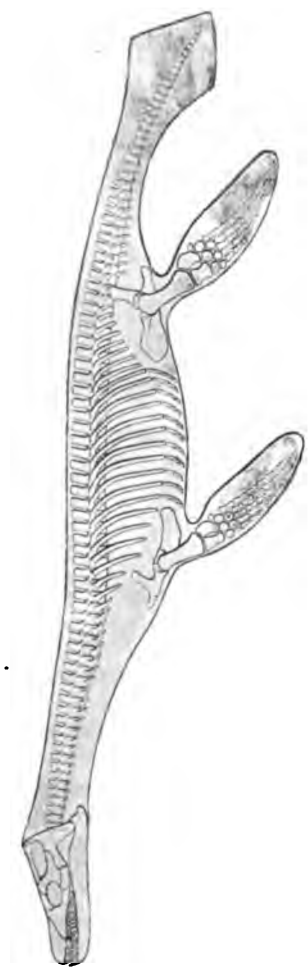


FIG. 29.—Skeleton of *Plesiosaurus macrocephalus*, with outline of body and tail-fin indicated in shading, from the Lower Lias of Lyme Regis; about one-eighteenth nat. size. The tail-fin has only been seen in one specimen of another species, now in the Royal Museum of Natural History, Berlin.

of the ribs, is strengthened not only by the expanded plates of bone which support the paddles, but also by many intervening rows of abdominal ribs. The tail is quite short, and is known to have been provided with a small rhomboidal

Cases P, Q. fin-membrane extended in a vertical plane (Fig. 29). The joints (phalanges) of the toes which form the paddles are more numerous than usual, as in the modern whales and porpoises. There is no trace of armour.

Table-case 26. The latest Sauropterygia of Cretaceous age seem to have been world-wide in distribution, but are illustrated in the collection only by fragments. Among these the powerful teeth of *Polyptychodon* (Fig. 30), from the Chalk, Greensand, and Gault, are noteworthy (Table-case 26). In the Upper Jurassic there are the large-headed short-necked Pliosauria, besides the small-headed long-necked Plesiosauria. *Pliosaurus* itself must have been a gigantic reptile, the skull and

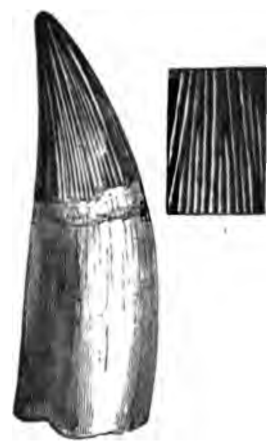


FIG. 30.—Tooth of *Polyptychodon interruptus*, from the Cambridge Greensand; one-half nat. size. A portion of the ribbed enamel of the crown is shown on the right, nat. size. (Table-case 26.)

Wall-case 10. jaws of *P. grandis*, from the Kimmeridge Clay, measuring 6 feet in length, while those of *P. ferox*, from the Oxford Clay, are not much smaller (Wall-case 10). *Peloneustes* (Fig. 31, A), with a slender snout, is an allied animal from the Oxford Clay. *Cryptoclidus* (Plate V.), well represented by the two skeletons from the Oxford Clay of Peterborough already mentioned (Cases P, Q), does not differ much from the Liassic *Plesiosaurus* (Fig. 29), except in the relations of the bones supporting the fore limbs. *Plesiosaurus* and

Wall-cases 11-14. closely similar genera from the English Lias are represented by a unique series of skeletons in Wall-cases 12, 13, 14. The plaster cast of a partially restored skeleton of

Plesiosaurus cramptoni, from the Upper Lias of Whitby (original in National Museum, Dublin), shows the large size sometimes attained. This specimen (Wall-case 13) measures 22 feet in length, and the span to the tip of the paddles is 14 feet. **Wall-case 13.**

The Triassic Sauropterygia comprised not only typical **Table-cases 24, 25.**

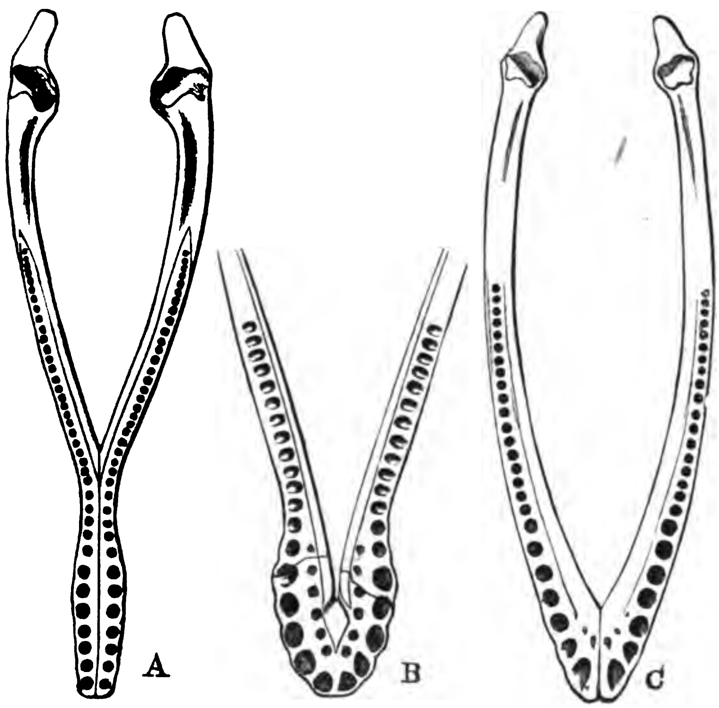


FIG. 31.—**Mandibles of Sauropterygia, upper view, without teeth. (A) *Peloneustes philarchus*, from the Oxford Clay of Peterborough; one-eighth nat. size. (B) *Thaumatosaurus indicus*, from the Upper Jurassic of India; one-seventh nat. size. (C) *Plesiosaurus dolichodeirus*, from the Lower Lias of Lyme Regis; one-quarter nat. size.**

aquatic reptiles such as *Nothosaurus* (Fig. 32) and *Pistosaurus* from the German and Italian Muschelkalk (Table-cases 24 and 25), but also smaller reptiles with limbs less completely adapted for swimming. These are commonly regarded as the ancestors of the Plesiosaurs, and as proof that they were descended from land animals. *Lariosaurus* (Fig. 33) and

Table-cases 24, 25. *Neusticosaurus* (Table-case 24) are typical examples, while

FIG. 32.—Skull and mandible of *Nothosaurus mirabilis*, right side-view from the Muschelkalk of Germany; one-sixth natural size. (Table-case 24).

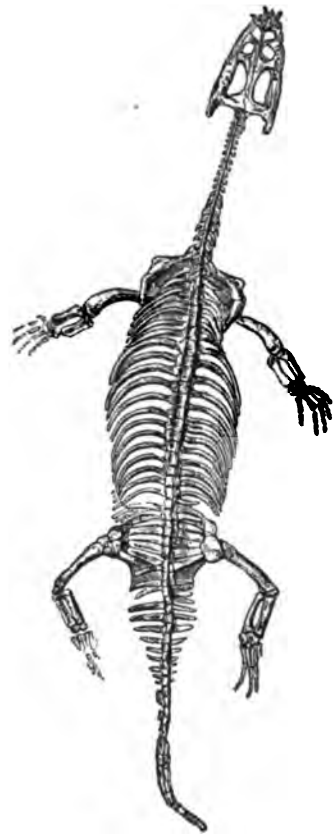


FIG. 33.—Skeleton of an early Sauropterygian (*Lariosaurus balsami*), from the Muschelkalk of Perledo, Como, Italy; one-eighth nat. size. Original in Munich Museum; plaster cast on wall near Table-case V.

the small *Mesosaurus* from South Africa and Brazil seems to be a close ally.

ORDER VIII.—ICHTHYOPTERYGIA.

Wall-cases 15–17. Stands A–C. Case H.

Fish-shaped or porpoise-shaped aquatic reptiles lived with the Sauropterygia and were equally cosmopolitan.

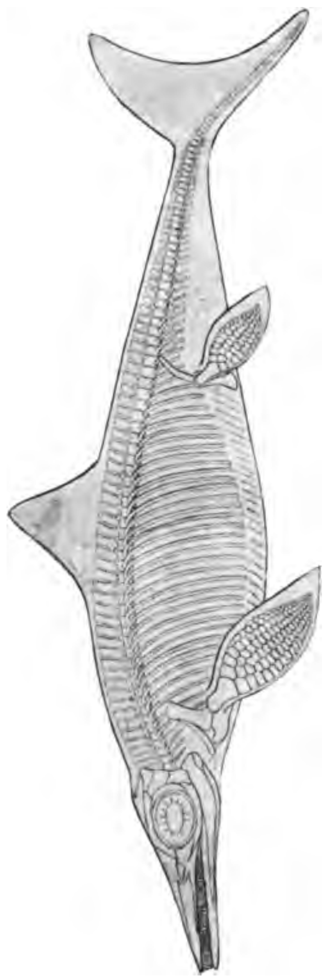


FIG. 34.—Skeleton of *Ichthyosaurus communis*, with outline of body and fins indicated in shading, from the Lower Lias of Lyme Regis; about one-thirtieth nat. size. (Wall-case 17.)

They form the Order of Ichthyosauria ("fish-lizards") or Ichthyopterygia ("fish-finned"), and the toe-bones in the paddles are not only pressed together into a mosaic, but are

Wall-cases 15–17. Stands A–C. Table-cases 20–23. Case H.

also supplemented by other small bones (Fig. 38). These reptiles (Fig. 34) are well illustrated by a unique collection

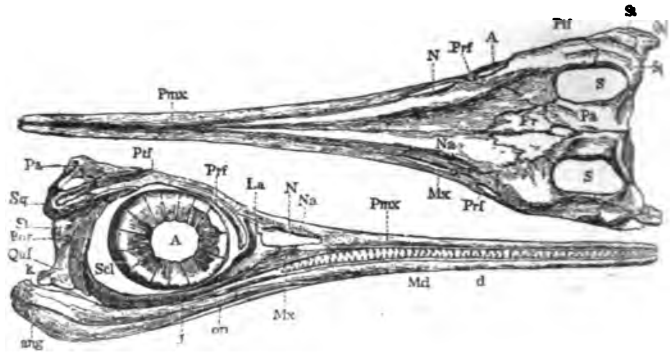


Fig. 35.—Skull and mandible of *Ichthyosaurus setlandicus*, from the Upper Lias of Normandy; about one-quarter nat. size. *A.* orbit; *ang.* angular; *d.* dentary; *Fr.* frontal; *J.* jugal; *k.* articular; *Md.* mandible; *Mx.* maxilla; *N.* nares; *Na.* nasal; *op.* splenial; *Pa.* parietal; *Pmx.* premaxilla; *Por.* postorbital; *Prf.* prefrontal; *Ptf.* postfrontal; *QuJ.* quadratojugal; *S.* supratemporal fossa; *Scl.* sclerotic ring; *Sq.* squamosal; *St.* supratemporal. (After Zittel. Table-case H.)

of skeletons, chiefly from the English Lias, in Wall-cases 15, 16, 17, and by smaller fragments in Table-cases 20 to 23. The large head (Fig. 35) is shaped like that of a porpoise, with an elongated snout and with powerful conical teeth (Fig. 36) set in a groove along the edge of the jaw. The nostril is just in front of the enormous eye, and this is strengthened by a ring of sclerotic plates which would help in focussing for varying distances. There is a conspicuous pineal foramen for a median eye in the top of the head (see skull in Table-case 21). The vertebræ (Fig. 37), which are very numerous, short, and biconcave, are shaped like those of a fish to insure flexibility of the backbone. The neck is quite short, while the vertebræ of the tail are sharply turned down at some distance from the end, to support a triangular vertical

Fig. 36.—Tooth of *Ichthyosaurus campylodon*, from the Lower Chalk of Folkestone; nat. size. (Table-case 20.)

Table-case 20.

FIG. 37.—Body or centrum of anterior dorsal vertebra of *Ichthyosaurus*, viewed in section, from the front and from the left side; from the Kimmeridge Clay of Wiltshire; one-half nat. size. (Table-case 20.)

Table-case 21.

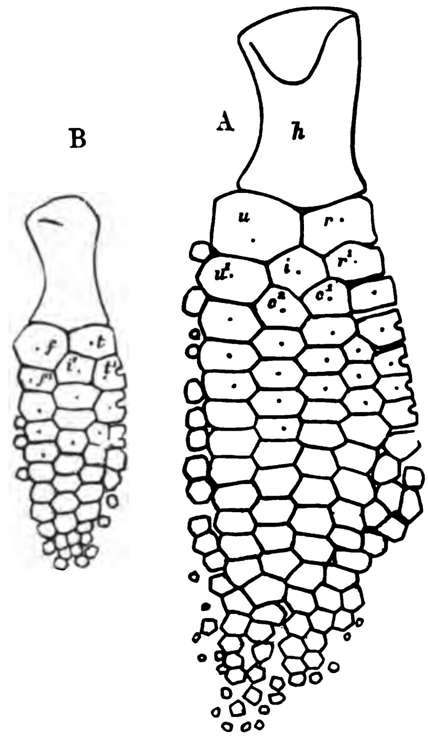


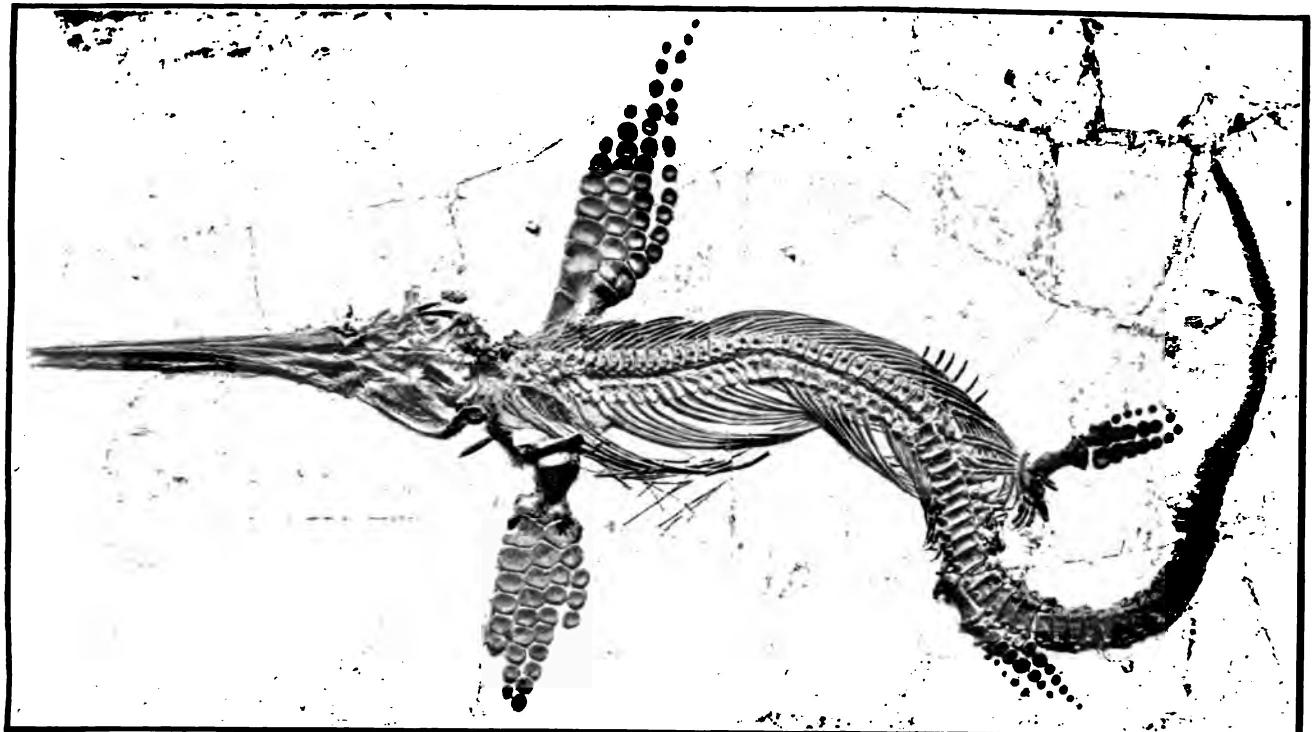
FIG. 38.—Right fore (A) and hind (B) paddles of *Ichthyosaurus intermedius*, from the Lower Lias of Lyme Regis; one-third nat. size. c^1, c^2. centralia; *f*. fibula; f^1. fibulare; *h*. humerus; *i*. intermedium; *r*. radius; r^1. radiale; *t*. tibia; t^1. tibiale; *u*. ulna; u^1. ulnare. (After Lydekker.)

Wall-cases 15–17. Stands A–C. Table-cases 20–23. Case H. tail-fin, which has been seen in a few well-preserved specimens from the German Lias and Lithographic Stone (not in the Collection). Both pairs of paddles (Fig. 38) are always present, but the hinder pair is often small. The skin must have been quite smooth, without armour, and it is shown in some German specimens (not in the Collection) to have formed a smooth triangular fin in the middle of the back, as in modern porpoises.

The small Triassic Ichthyosaurs, of which there are no specimens in the Museum, suggest that they, like the Plesiosaurs, were descended from land animals. In some important respects the skull and teeth resemble those of the Labyrinthodont Amphibia (p. 47). The Liassic Ichthyosaurs, of which a fine series is exhibited in Wall-cases 15, 16, 17, are typical members of the Order and sometimes attain a very large size. The skeleton of *Ichthyosaurus platyodon*, from the Lower Lias of Stockton, Warwickshire, **Wall-case 16.** presented by Mr. Michael H. Lakin, measures 22 feet in length; while vertebræ at the bottom of the same Wall-case and skulls in Gallery 3 (pedestals lettered A, B, C) belong to much larger individuals. A nearly complete small skeleton from the Lower Lias of Street, Somersetshire (Plate VI.), is an especially good example of a slender-nosed species (Wall-case 15). An equally good specimen of an allied species from the Upper Lias of Würtemberg, at the bottom of the same Wall-case, is interesting as showing six embryos within the ribs, proving that these reptiles were viviparous. Two fragments from the Lower Lias of Barrow-on-Soar, Leicestershire (Wall-case 17 and Table-case 21), exhibit the fin-membrane round the bones of the fore-paddle.

Typical Ichthyosaurs seem to have ranged upwards to the Chalk, and fragmentary remains of the later species are **Table-case 20.** exhibited in Table-case 20. Some of the Upper Jurassic genera, however, both in Europe and in North America, are almost toothless and have broad paddles, which must have been rendered very flexible by a persistent rim of cartilage round each of the constituent bones. *Ophthalmosaurus* is a typical and well-known example from the Oxford Clay of Peterborough (Table-case 23).

Case G. Coprolites, or pieces of fossilised excrement, are often found in the Lias where remains of Plesiosaurs and Ichthyosaurs occur, and were probably left by these reptiles. A collection is exhibited in Table-case G. They contain numerous scales of ganoid fishes which have been eaten, and



Skeleton of a Marine Ichthyosaurian (*Ichthyosaurus tenuirostris*) from the Lower Lias of Street, Somersetshire; about one-eleventh nat. size. (Wall-case 15.)

[*To face p.* 40.

many of them are marked by a spiral line, which bears witness to the spiral form of the membrane in the intestine through which they originally passed. **Case G.**

ORDER IX.—**CHELONIA.**

The tortoises and turtles date back to the Triassic period, when they seem to have already assumed their most **Wall-cases 18, 19. Cases W to Z.**

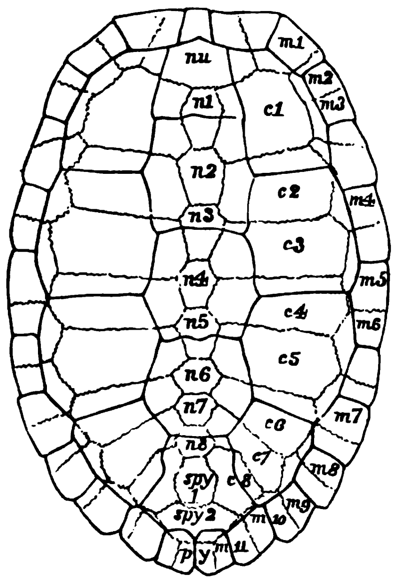


FIG. 39.—Carapace or dorsal shield of a small Tortoise (*Hardella thurgi*), from the Pliocene of the Siwalik Hills, India; reduced in size. The wavy lines show the divisions (or sutures) between the bones; the firm lines indicate those between the overlying horny shields. *c.* 1–8, costal bones; *m.* 1–11, marginal bones; *n.* 1–8, neural bones; *nu.* nuchal bone; *py.* pygal bone; *spy.* 1, 2, suprapygal shields. (After Lydekker.)

characteristic features. Fragments of a typical Chelonian shell (*Chelytherium obscurum*) are exhibited from the Keuper Sandstone near Stuttgart, Germany. **Wall-case 19.**

SUB-ORDER 1.—**Trionychia.**

The three-clawed mud-turtles appear with all their typical characters in the Eocene both of Europe and North America. **Wall-case 18.**

Well-preserved shells and other remains of *Trionyx* from the Upper Eocene of Hampshire are exhibited in Wall-case 18.

SUB-ORDER 2.—**Cryptodira.**

Wall-cases 18, 19. Cases W to Z.

Most of the known extinct Chelonia, like the majority of existing tortoises and turtles, belong to the sub-order Crypto-

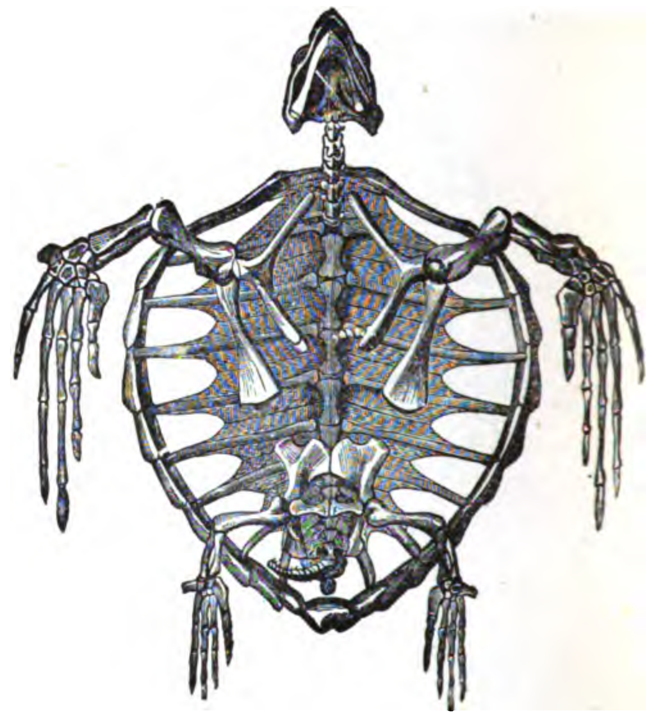


FIG. 40.—Lower view of the skeleton of the existing Logger-head Turtle (*Thalassochelys caretta*); much reduced in size.

dira ("hidden-necked"), in which the head is retracted by curvature of the neck in a vertical plane. The pelvis in these reptiles is not directly connected with the ventral armour or plastron.

The ordinary marsh and land tortoises first occur in Eocene rocks, where modern kinds are associated with several extinct genera. Typical specimens are shown from the

London Clay of Sheppey in Table-case W. Large tortoises (*Testudo ammon*) are also exhibited from the Upper Eocene of Egypt (Wall-case 19); and there are still larger specimens (*T. grandidieri*) from caverns in Madagascar (Stands Y, Z). The largest known tortoise is *Colossochelys atlas*, from the Lower Pliocene of the Siwalik Hills, India, represented by fragments in Wall-case 18, and by a restored model of the shell (Stand X), which measures 8 feet in length. Like all other tortoises, this must have been a vegetable-feeder. The **Wall-cases 18, 19. Cases W to Z.**

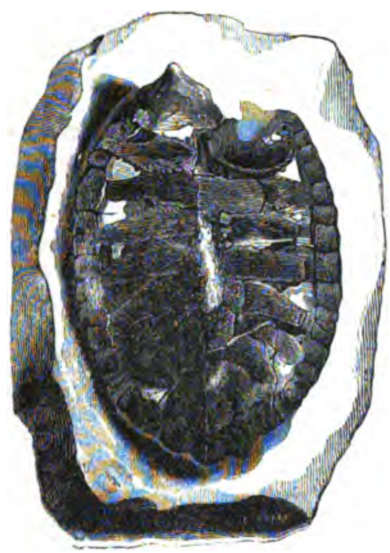


FIG. 41.—Carapace or dorsal shield of a small Turtle (*Chelone benstedi*) from the Lower Chalk of Burham, Kent; about one-third nat. size. (Wall-case 18.)

last survivor of the tortoises in England was *Emys orbicularis*, of which shells have been found in Pleistocene deposits in Norfolk. This species still survives in southern Europe.

The earliest typical turtles are of Cretaceous age, and fine specimens of the large *Chelone hoffmanni* are exhibited from the Upper Chalk of Maastricht, Holland (Wall-case 18). Fragments of similar turtles, with remains of smaller species such as *Chelone benstedi* (Fig. 41), also occur in the English Chalk. Skulls of *Rhinochelys* are common in the Cambridge Greensand. A gigantic leathery turtle, *Eosphargis gigas*, is **Wall-case 18.**

Wall-case 18. represented by a well-preserved skull and other remains from the London Clay of Sheppey. There are also small species of extinct genera of true turtles in the same formation (*e.g.*, *Argillochelys*).

The fresh-water *Chelydra*, now confined to the warmer parts of the New World, has been discovered in the Upper Miocene of Oeningen, Baden (Wall-case 18).

SUB-ORDER 3.—**Pleurodira.**

Wall-case 19. The existing Chelonia which withdraw their head by bending the neck sideways to rest within the margin of the shell, are now confined to the southern hemisphere; but in Tertiary times they were also common in the northern hemisphere. Various fragmentary remains, including shells of *Podocnemys* from the Eocene of Egypt, are exhibited in Wall-case 19. The most noteworthy extinct genus is the horned *Miolania*, which occurs not only in the Pleistocene of Queensland (Plate VII.) and Lord Howe's Island (400 miles distant from the Australian coast), but also in rocks of uncertain age in Chubut, north of Patagonia (Plate VII.). The tail in this reptile is armoured with thick bony rings like those of the extinct South American armadillo, *Glyptodon*. As *Miolania* must have been a land-animal, its discovery in regions so remote as Australia and South America is sometimes cited as one proof of the former existence of a great Antarctic continent uniting the lands in question.

SUB-ORDER 4.—**Amphichelydia.**

Wall-case 19. Most of the Jurassic and Wealden Chelonia are somewhat intermediate between the Cryptodira and Pleurodira, and have been provisionally placed in a separate sub-order. Among typical examples may be mentioned *Pleurosternum* from the Purbeck Beds of Swanage and *Platychelys* from the Lithographic Stone (Kimmeridgian) of Bavaria (Wall-case 19).

A

B

SKULLS OF TWO SPECIES OF A HORNED TORTOISE (MIOLANIA).

A. *Miolania argentina*, from the supposed Cretaceous of Chubut, Patagonia.
B. *Miolania oweni*, from the Pleistocene of Queensland. (Wall-case 19.)

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GALLERIES Nos. 4, 5.—FOSSIL AMPHIBIANS.

The frogs, newts, salamanders and their allies are intermediate in all essential respects between reptiles and fishes. It is therefore interesting to note that the Class Amphibia, to which they belong, attained most importance in Carboniferous and Permian times, between the Devonian period, when fishes were the highest kind of life, and the Triassic period, when the "Age of Reptiles" dawned. Since Triassic times, indeed, the Amphibia seem to have been degenerate and insignificant animals, and the geological record is so incomplete that it furnishes none of the links connecting these later Orders with the Order which represented the Class in its prime. **Wall-case 19. Table-cases U, V.**

CLASS IV.—AMPHIBIA.

ORDER I.—**ANURA** or **ECAUDATA.**

The frogs and toads, or tailless Amphibians, seem to have undergone scarcely any essential change since the Eocene and Oligocene periods. Fine specimens both of adult individuals and tadpoles are exhibited from the Lower Miocene lignite of Rott, near Bonn, and impressions of the soft parts often surround the fossils. *Palæobatrachus* is an extinct toad representing a family intermediate between certain existing groups. **Table-case U.**

ORDER II.—**URODELA** or **CAUDATA.**

The newts and salamanders have also changed but little since the Eocene and Oligocene periods. They are proved, indeed, to date back to the end of Jurassic times by a single skeleton (*Hylæobatrachus croyi*) from the Wealden of Bernissart, Belgium, now in the Brussels Museum. Newts are exhibited from the Lower Miocene of Rott, near Bonn, and **Wall-case 19. Table-case U.**

Wall-case 19. Table-case U.

among the salamanders there is a large specimen of *Cryptobranchus scheuchzeri* (Fig. 42) from the Upper Miocene of Oeningen, Baden, in Wall-case 19. This gigantic salamander is closely related to a species still surviving in Japan.

FIG. 42.—Skeleton of a gigantic Salamander (*Cryptobranchus scheuchzeri*) from the Upper Miocene of Oeningen, Baden; one-tenth nat. size. "Homo diluvii testis" of Scheuchzer. (Wall-case 19.)

Another specimen of the same animal, now in the Teyler Museum, Haarlem, was mistaken for a human skeleton by Scheuchzer, who described it in 1726 as *Homo diluvii testis*—"man a witness of the deluge."

ORDER III.—STEGOCEPHALIA.

Wall-case 19. Table-cases U, V.

As already mentioned, the most important Amphibians are those which flourished in the Carboniferous and Permian periods, and disappeared at the end of the Trias. They must have resembled crocodiles and salamanders in outward appearance, and they are known as Stegocephalia ("roofed-heads"), because the space for their biting muscles is always roofed by plates of bone, arranged much like those of the contemporary paddle-finned fishes. The skull is nearly always pitted or sculptured like that of a crocodile, and is marked with symmetrically-arranged grooves for slime-canals. There is always a pineal foramen. The palate resembles that of the modern Amphibia, and, as in the latter, the skull is fixed to the backbone by a pair of occipital condyles. The clavicles and interclavicle are expanded into large breast-plates, which are usually sculptured; and behind these there is nearly always an armour of small bony scales arranged in a chevron pattern.

Remains of Stegocephalia are found in nearly all parts of the world, including Australia.

SUB-ORDER 1.—Labyrinthodontia.

The largest and most typical Stegocephalia possess powerful conical teeth, which are curiously complicated in structure. Each tooth is a hollow cone, with the wall folded inwards in numerous vertical pleats, which are crumpled where crushed together. In allusion to this peculiarity, which is well shown by a tooth of *Mastodonsaurus* in Table-case V, the animals are named Labyrinthodontia ("labyrinth-toothed"). **Wall-case 19. Table-case V.**

The largest Labyrinthodonts are those from the Upper

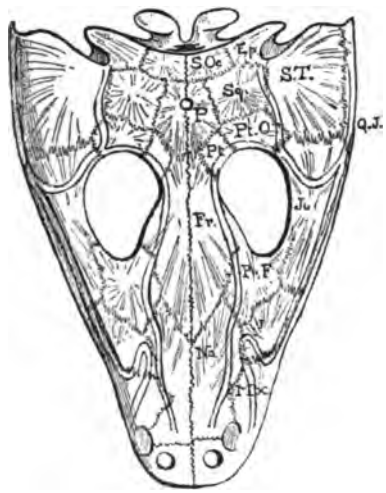


FIG. 43.—Skull of *Mastodonsaurus giganteus*, upper view with sculpture omitted, from the Lower Keuper of Würtemberg; about one-eighth nat. size. *Ep.* lateral supratemporal; *Fr.* frontal; *Ju.* jugal; *L.* lachrymal; *Mx.* maxilla; *Na.* nasal; *P.* parietal; *Pr.f.* prefrontal; *Pt.* postfrontal; *Pt.o.* postorbital; *Q.J.* quadratojugal; *S.T.* prosquamosal; *S.Oc.* inner supratemporal; *Sq.* squamosal. The double lines indicate slime-canals. (After E. Fraas.)

Trias of Würtemberg referred to *Mastodonsaurus*. The skull of *M. giganteus* (Fig. 43) sometimes measures 4 feet in length. A plaster cast of a smaller skull is exhibited in Wall-case 19, and fragments of actual bones and teeth of the same genus are placed in Table-case V. *Capitosaurus* is another well-known Triassic genus, comprising species of smaller size, represented in Wall-case 19, not only by skulls from Germany, but also by a well-preserved skull from the Keuper Sandstone of Stanton, near Uttoxeter, North Staffordshire.

Wall-case 19. Table-case V.

Metoposaurus, from the Trias of Würtemberg, has the eyes far forward in the head. *Rhytidosteus* and *Bothriceps* (Fig. 44), from the Trias of South Africa and Australia (Table-case V), are also noteworthy.

The Permian Labyrinthodonts in the collection belong chiefly to *Archegosaurus* and *Actinodon*, and are interesting as showing parts of the body and limbs. The remains of *Archegosaurus decheni*, in nodules from the Lower Permian of Rhenish Prussia, are especially well preserved. The backbone is incompletely formed, each vertebra consisting of three or more pieces, surrounding a large persistent strand of noto-

FIG. 44.—Skull of *Bothriceps huxleyi*, upper view, from the Triassic Karoo Formation of Orange River Colony, South Africa; four-fifths nat. size. (Table-case V.)

chord, much like the vertebra of *Euchirosaurus* from France (Fig. 45), and that of *Eryops*, from Texas, in Table-case V. The ribs are short, and evidently did not completely encircle the trunk, so that in breathing the animal must have swallowed air like a frog. The ends of the limb-bones were originally cartilaginous, and hence are not preserved in the fossils. Traces of gill-arches can sometimes be seen in young specimens, proving that *Archegosaurus* resembled modern Amphibia in breathing by gills during the earlier part of its life.

Among the remains of Carboniferous Labyrinthodonts an uncrushed skull of *Loxomma*, obtained by Mr. George Maw from ironstone in the Coal Measures of Coalbrookdale, is particularly interesting (Wall-case 19). Owing to their

imperfect ossification, nearly all the skulls of these animals are flattened by pressure in the rocks. Other remains of *Loxomma* and *Anthracosaurus* are exhibited from the English Coal Measures, and these include short biconcave vertebræ which resemble those of *Ichthyosaurus*, except that they are **Wall-case 19. Table-case V.**

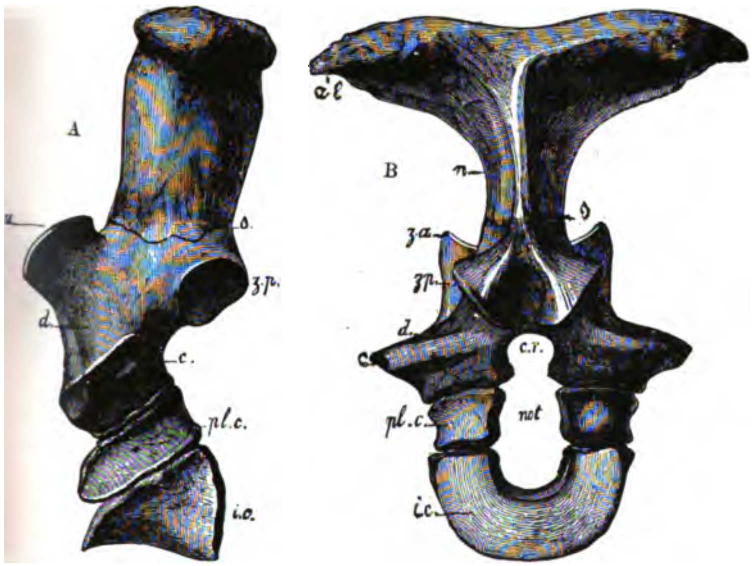


Fig. 45.—Vertebra of *Euchirosaurus rochei*, left lateral (A) and posterior (B) views, from the Lower Permian of France; about nat. size. *al.* lateral expansion of neural arch; *c.* facette for rib; *c.r.* neural canal; *d.* transverse process of neural arch; *ic.* hypocentrum or intercentrum; *n.* neural spine; *not.* space originally occupied by notochord; *pl.c.* pleurocentra; *s.* suture between neural arch and spine; *z.a.*, *z.p.*, anterior and posterior zygapophyses. (After A. Gaudry.)

pierced by a hole for a remnant of the notochord. In Wall-case 19 there is also an incomplete skeleton of *Pholidogaster* from the Lower Carboniferous of Scotland. The limbs of the Lower Carboniferous Labyrinthodonts are unknown.

Sub-order 2.—**Microsauria.**

In Upper Carboniferous and Lower Permian rocks there are remains of numerous small lizard-shaped Stegocephalia, named Microsauria ("little lizards"), which are in some respects intermediate between the Amphibia and the true Reptilia. **Wall-case 19. Table-case U.**

Wall-case 19. Table-case U.

The skull is typically Stegocephalian, with two bony occipital condyles, and with the teeth comparatively simple in structure. The vertebræ are constricted cylinders, and the ribs are sometimes as long and slender as in a lizard.

Remains of Microsauria were first discovered inside decayed tree-stumps in the Coal Measures of South Joggins, Nova Scotia, where the little animals had evidently been trapped by accident. Numerous skeletons have since been found in Coal Measures of other localities both in North America and Europe and in the Lower Permian Coal Measures of Bohemia. Some of the original bones of *Hylonomus* discovered by Sir William Dawson in the decayed trees in Nova Scotia are exhibited in Table-case U. Specimens of *Ceraterpetum* are also shown from the Coal Measures of Kilkenny and Staffordshire; and there are electrotypes of this and several other kinds from the Lower Permian of Bohemia. Most of the Bohemian specimens are pyritised, so that they cannot be permanently preserved. Dr. Anton Fritsch has devised the ingenious plan of making electrotypes from the moulds in the shale from which the decayed bones have been removed, and the exact copies of these fossils now exhibited are the result of his work.

SUB-ORDER 3.—**Aistopoda.**

Wall-case 19.

These closely resemble the Microsauria, with which they are found, but they are shaped like snakes and destitute of limbs. Remains of *Dolichosoma* and *Ophiderpetum* are exhibited.

SUB-ORDER 4.—**Branchiosauria.**

Table-case U.

The Branchiosauria ("gilled lizards") are so named because traces of the gill-supports are always conspicuous in young individuals. They are small animals like salamanders, with barrel-shaped vertebræ and short ribs. They are known only from the Lower Permian of France, Saxony, Bohemia, and Moravia. Numerous specimens of *Branchiosaurus* are exhibited from Saxony; and there is one individual from Bohemia showing an impression of the long soft tail on the black shale in which the skeleton is imbedded. The small *Protriton* from France and the relatively large *Melanerpeton* from Moravia are also represented by typical examples.

GALLERY No. 11.—FOSSIL FOOTPRINTS.

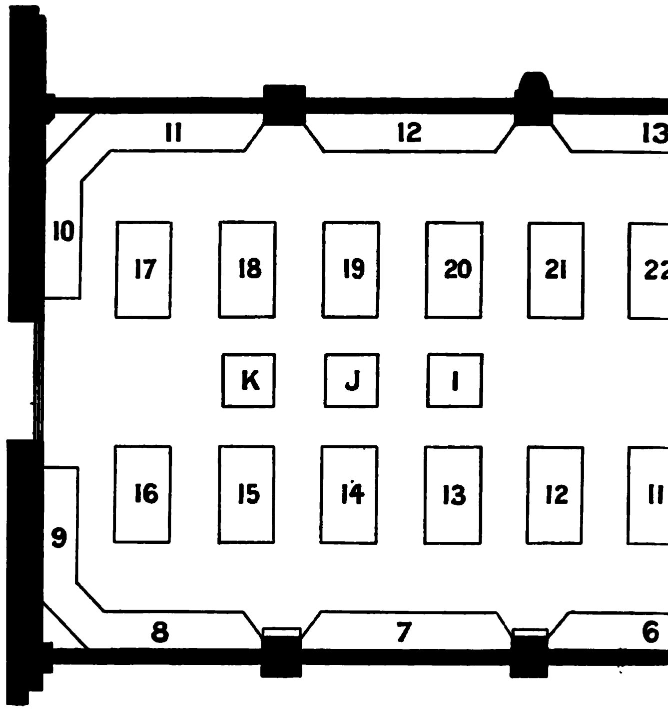
Under certain circumstances footprints may be preserved as fossils, and in some rocks of Triassic and Permian age the only evidence of life is afforded by such footprints. There is **Gallery 11, Wall-cases 8–10.**

FIG. 46.—Footprints of *Cheirotherium barthi*, with sun-cracks, from the Bunter Sandstone of Hessberg, Saxony; about one-tenth nat. size. (Wall-case 10, Gallery 11.)

a large series of these fossils in the collection, and as they cannot yet be ascribed to the animals which made them, they are arranged together in Gallery 11, Wall-cases 8–10. Most of the footprints from the English and German Trias (Fig. 46)

Gallery 11, Wall-cases 8–10.

are shaped somewhat like impressions of a human hand and hence are referred to an unidentified *Cheirotherium* ("hand-beast"). There are small prints for the fore feet and large prints for the hind feet, and a close examination of the tracks shows that the "opposable thumb" is on the outer side of the foot, so really corresponds with the little finger or little toe of man. The so-called *Ichnium sphærodactylum* from the Permian of Thuringia is a nearly similar footprint, and is scattered over a large slab of red sandstone in Wall-case 10, which also exhibits suncracks and rainprints. Three-toed footprints from the Trias of North America (Wall-case 9) were probably made by Dinosaurs. Some large three-toed footprints of *Iguanodon* from the Wealden of Hastings are placed for comparison in Wall-case 8; and there is, on an adjoining stand, a slab of Purbeck Stone bearing similar impressions.



PLA

CONTENTS OF WALL-CASES.

1, 2. Elasmobranchii. 3. Elasmobranchii and Holocephali. 4. ! Crossopterygian Teleostomi. 7. Crossopterygian and Chondro 8. Chondrostean Teleostomi. 9-18. Protospondylic Teleostomi. 1 and Aetheospondylic Teleostomi. 15. Isospondylic Teleostomi. Ostariophysian, and Acanthopterygian Teleostomi. 17, 18. Teleostomi.

GALLERY No. 6.—FOSSIL FISHES.

As fishes are aquatic animals and as most fossiliferous rocks have been formed in water, fish-remains are naturally very abundant among fossils. The geological record of their past history, however, is much more imperfect than might have been expected; for almost the only good specimens are those obtained from shoals which have been suddenly destroyed and quickly buried. Our real knowledge therefore depends on a succession of local accidents, which reveal only isolated episodes instead of a continuous story. Even these episodes are incompletely recorded, because the skeletons of a large proportion of the lower fishes are too little hardened with lime (or "calcified") to become fossilised when buried in rock.

Class V.—AGNATHA.

It is probable that all the earliest fish-like animals were destitute of hard parts capable of fossilisation, because no links have yet been found between fishes and the invertebrate animals below. When they first appear in Upper Silurian rocks their fossilised remains merely represent skin-armour, so that it is difficult to ascertain precisely the nature of their organisation. There is not much doubt, however, that the forerunners of the fishes lacked both a lower jaw as ordinarily fashioned and paired fins corresponding with the arms and legs of land animals. They are therefore arranged in a distinct Class of Agnatha ("without jaws") below that of Pisces (or fishes proper). These primitive animals occupy some of the small Cases in the middle of Gallery 6.

Table-cases A-E.

Order I.—**OSTRACODERMI.**

Nearly all known Agnatha of the Silurian and Devonian periods are armoured with hard skin-tubercles, which are like the placoid scales of sharks, but often united into plates by

Table-cases A–E. an undergrowth of thin hard layers, bearing a superficial resemblance to ordinary shell. These are therefore named Ostracodermi ("shell-skinned") or Ostracophori ("shell-bearers").

SUB-ORDER 1.—**Anaspida.**

Table-case A. A few small Ostracoderms of Upper Silurian age are laterally compressed and gracefully fusiform, with one small dorsal fin and a heterocercal tail (see p. 61). The hard skin-tubercles on their head are not fused into plates, but those on the trunk have coalesced into well-formed scales, arranged in rows which slope from behind forwards instead of the reverse or ordinary way. *Birkenia* (Fig. 47) and *Lasanius* occur in the Downtonian formation of southern

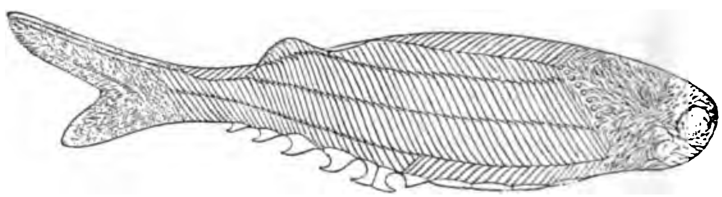


FIG. 47.—Restoration of *Birkenia elegans*, from the Downtonian of Lanarkshire; about nat. size. (After R. H. Traquair. Table-case A.)

Scotland, the former completely armoured, the latter showing only a few thick and deepened scales on the anterior part of the trunk besides a row of large recurved spines along the lower border. *Euphanerops* seems to have been a survivor of the Anaspida in the Upper Devonian of Canada.

SUB-ORDER 2.—**Heterostraci.**

Table-case A. In this group of Ostracoderms the head and gill-chamber region is relatively large, broad and depressed, so that it is exposed from above or below in the fossils; while the tail is slender and, seen in side view, ending in a forked tail-fin. The eyes are wide apart on the sides of the head. The mouth must have been underneath the head, and the opening from the gill-chamber on each side is at the hinder angle of the expanded front part of the animal. When the hard skin-tubercles are fused into plates, the underlying layers never contain true bone-cells.

The simplest of these Heterostraci ("anomalous-shelled")

are the Cœlolepidæ ("hollow scales"), which seem to have flourished earliest and must have been especially abundant in late Silurian seas. Their skin-tubercles were never united into plates, and when these little bodies were originally discovered in immense numbers in the Ludlow Bone-bed at the top of the Silurian formation on the borders of Shropshire (Table-case A) they were naturally mistaken for the placoid scales of sharks. It is only under exceptional circumstances that the animals covered with so incoherent an armour could be preserved intact, but good specimens have been found in the Upper Silurian and Downtonian shales of southern Scotland (Table-case A). In *Thelodus* the tubercles are quadrangular and flattened, while in *Lanarkia* (Fig. 48) **Table-case A.**

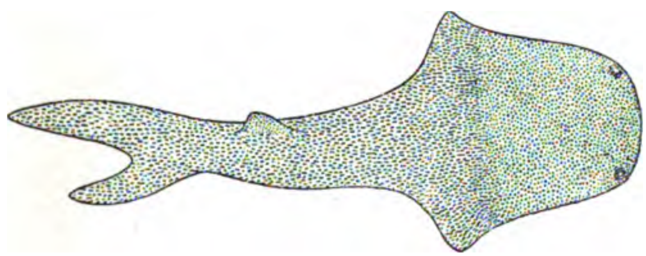


Fig. 48.—Restoration of *Thelodus scoticus*, from the Downtonian of Lanarkshire; about one-half nat. size. The head is shown from above, the tail twisted, to be seen mainly in side-view. (After R. H. Traquair. Table-case A.)

they are conical prickles of variable size. The internal skeleton is never preserved.

In the Pteraspidæ the skin-tubercles are united into plates and scales, and form fine enamelled ridges concentric with the edges. This family also flourished in the Upper Silurian, but is commoner and better developed in the Lower Devonian. *Cyathaspis* (Fig. 49) has been found in the Wenlock rocks of Gothland and in the Upper Silurian both of Europe and North America. It is the oldest fish-like organism of which there is any definite knowledge. *Pteraspis* (Figs. 50, 51) is a typical Lower Devonian genus, and numerous specimens are exhibited from the Lower Old Red Sandstone of the Welsh border. **Table-case A.**

The latest Heterostraci, which range from the Lower to the Upper Devonian, comprise some relatively large species, perhaps 2 feet in length, and form the family Psammosteidæ (Table-case B). The skin-tubercles fuse into small **Table-case B.**

Table-case A.

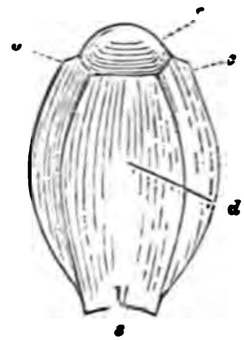


FIG. 49.—Diagram of dorsal shield of *Cyathaspis banksi*, upper view, from the Upper Silurian and Downtonian of Herefordshire; slightly reduced. *c*, cornua; *d*, median disc; *o*, position of orbit; *r*, rostral plate; *s*, posterior dorsal spine. (After Lankester. Table-case A.)

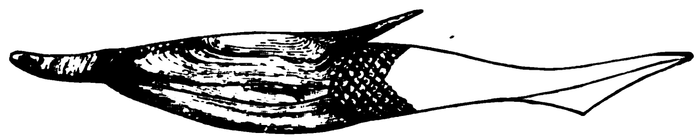


FIG. 50.—Restoration of *Pteraspis rostrata*, left side-view, from the Lower Old Red Sandstone of Herefordshire; about one-third nat. size. (After A. S. Woodward. Table-case A.)

FIG. 51.—Dorsal shield of *Pteraspis rostrata*, upper view, from the Lower Old Red Sandstone of Herefordshire; about one-third nat. size. (After Lankester. Table-case A.)

polygonal plates, of which some are again united into large bilaterally symmetrical or paired shields. Good examples of *Drepanaspis* (Fig. 52) are exhibited from the Lower **Table-case B.**

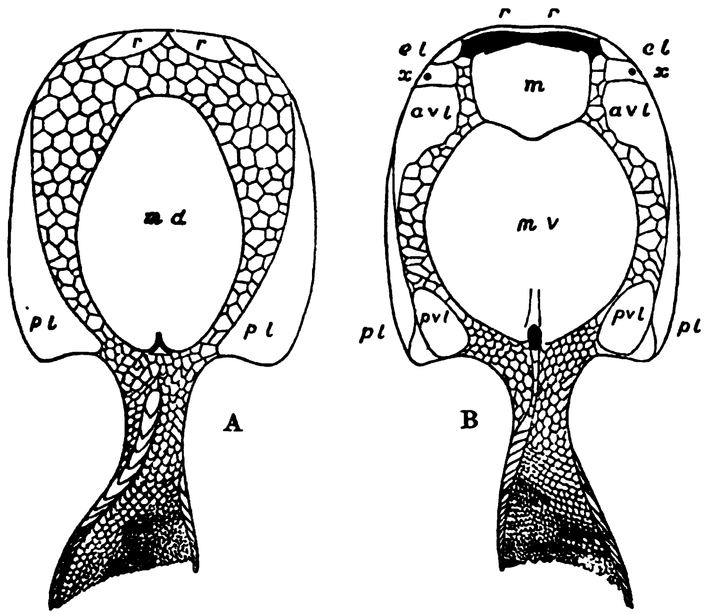


FIG. 52.—Restoration of *Drepanaspis gemuendenensis*, upper (A) and lower (B) view, from the Lower Devonian of Bundenbach, Germany; one-quarter nat. size. *a.v.l.* anterior ventro-lateral; *e.l.* external labial; *m.* mental, behind mouth; *m.d.* median dorsal; *m.v.* median ventral; *p.l.* postero-lateral; *p.v.l.* posterior ventro-lateral; *r.* rostral; *x.* orbital plate with orbit. (After R. H. Traquair. Table-case B.)

Devonian of Gmünden in Rhenish Prussia; and there are numerous fragments of *Psammosteus* from the Upper Devonian of Scotland, N.W. Russia, and Spitzbergen.

SUB-ORDER 3.—**Osteostraci.**

The Osteostraci ("bony-shelled") differ from the Heterostraci in the presence of bone-cells in some of the lower layers which unite the skin-tubercles into plates. They also differ in having the eyes close together on the top of the head. The Cephalaspidæ are the best-known family, ranging from the Upper Silurian to the Middle or even Upper Devonian, but **Table-cases B, C.**

Table-cases B, C.

specially characteristic of the Lower Devonian both in Europe and North America. The unique collection of *Cephalaspis murchisoni* (Fig. 53) from the Lower Old Red Sandstone Passage Beds of Herefordshire, and fine specimens of other species from the Lower Old Red Sandstone of Scotland exhibit nearly all the principal characters of the family (Table-cases B, C). At the back of the head region there is a pair of flippers, which seem to have assisted the expulsion

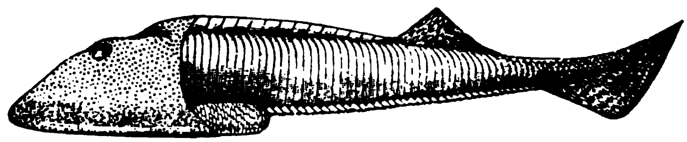


FIG. 53.—Restoration of *Cephalaspis murchisoni*, left side-view, from the Lower Old Red Sandstone Passage Beds of Herefordshire; about one-half nat. size. (After A. S. Woodward. Table-case B.)

of water from the gill-cavities. The scales on the sides of the trunk are deep and narrow. There is a small dorsal fin, and the tail is heterocercal (see p. 61). The Tremataspidæ comprise *Tremataspis* from the Upper Silurian of the Isle of Oesel (Baltic Sea) and *Didymaspis* from the Lower Old Red Sandstone Passage Beds (Downtonian) of Herefordshire.

SUB-ORDER 4.—**Antiarchi.**

Table-cases D, E.

These are the highest Ostracoderms, and are exclusively Devonian both in Europe and North America. The head and the anterior part of the trunk are covered with symmetrically-arranged overlapping plates, of which the lower layers contain bone-cells. The eyes are close together on the top of the head, which is movable on the trunk. A pair of toothed jaws of an unusual kind is fixed in front of the mouth. A pair of paddle-like appendages, each encased in plates and divided by one movable cross-joint, is articulated with the anterior angle of the body. The tail is heterocercal, and there is at least one small dorsal fin. The earliest known genus *Pterichthys* (Fig. 54), is represented by an unique collection of specimens from the Middle Old Red Sandstone of Scotland in Table-case D; and with these there are two paper models made by the original discoverer, Hugh Miller. The tail of *Pterichthys* is scaly, but that of the Upper Devonian genera

Asterolepis and *Bothriolepis* seems to have been naked. Well- **Table-cases D, E.**

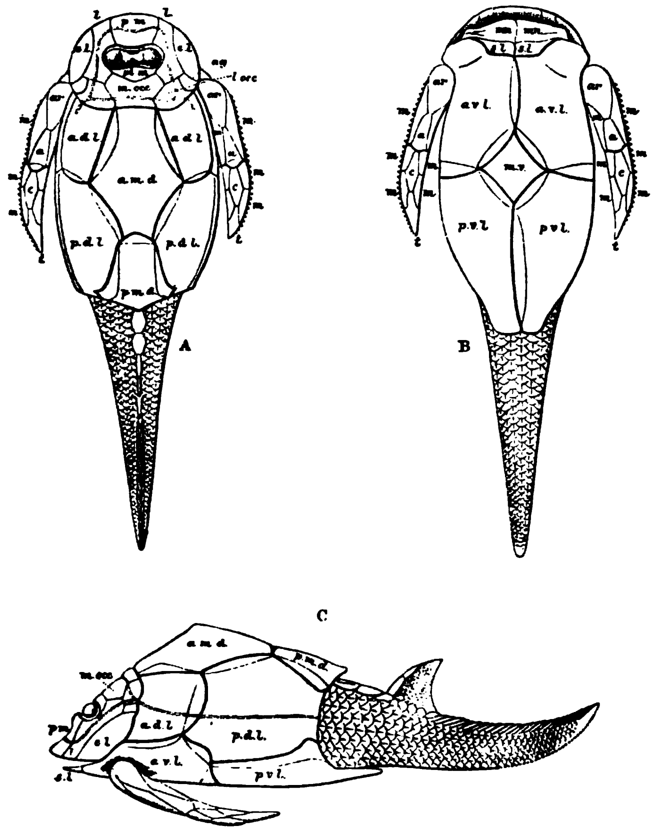


FIG. 54.—Restoration of *Pterichthys milleri*, upper (A), lower (B), and left side-view (C), from the Middle Old Red Sandstone of Scotland; about one-half nat. size. *a*, anconeal; *a.d.l.* anterior dorso-lateral; *a.m.d.* anterior median dorsal; *a.v.l.* anterior ventro-lateral; *ag.* angular; *ar.* articular; *c.* central of lower limb; *e.l.* extra-lateral or operculum; *l.* lateral; *l.occ.* lateral occipital; *m.* marginal; *m.occ.* median occipital; *m.v.* median ventral; *mn.* mandibular plates (displaced backwards in the drawing); *p.d.l.* posterior dorso-lateral; *pm.* premedian; *p.m.d.* posterior median dorsal; *p.v.l.* posterior ventro-lateral; *pt.m.* post-median; *s.l.* semi-lunar; *t.* terminal. (After R. H. Traquair. Table-case D.)

preserved examples of *Bothriolepis canadensis*, from the Province of Quebec, are especially noteworthy.

ORDER II.—CYCLIÆ.

Table-case E.

The problematical small skeleton named *Palæospondylus gunni* (Fig. 55), from the Middle Old Red Sandstone of Caithness, seems to represent an otherwise unknown Order, which may perhaps be referred to the Agnatha. It is never more than about two inches in length, and the collection in Table-case E is thus supplemented by some enlarged wax-models of the fossil ingeniously made by the donor, Prof.

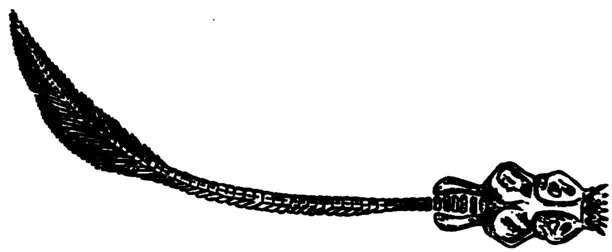


FIG. 55.—Restoration of *Palæospondylus gunni*, from the Middle Old Red Sandstone of Caithness; nearly twice nat. size. (After R. H. Traquair. Table-case E.)

W. J. Sollas. The head exhibits tentacle-shaped processes round an opening at the front end, and the roof of the brain-case is not sufficiently hardened for preservation. Bars which seem to be gill-arches occur below the back of the head, and they are connected in some way with a pair of plates extending behind the head. There are ring-vertebræ, and the tail is heterocercal, with hardened rays. There is no skin-armour.

Palæospondylus shows some striking resemblances to the lampreys, and it is quite possible that the existing Marsipobranchii are the degenerate survivors of the Agnatha.

CONODONTS.

Table-case E.

Minute tooth-like bodies named Conodonts (Fig. 56) found detached in Palæozoic rocks from the Lower Silurian to the

FIG. 56.—Cambrian Conodonts, ten times nat. size. (After G. J. Hinde. Table-case E.)

Carboniferous Limestone inclusive, are sometimes compared with the teeth of lampreys and hag-fishes, but their exact nature is very doubtful. Specimens are exhibited from the Lower Carboniferous of Ohio, U.S.A. (Table-case E). Table-case E.

CLASS VI.—PISCES.

The earliest true fishes, with a well-formed lower jaw and paired fins, are represented by rare and fragmentary remains at the top of the Silurian rocks. Better-preserved specimens in the Lower Old Red Sandstone show them to have possessed only a cartilaginous internal skeleton, and no bone-cells in their external armour. They therefore probably belong almost to the same grade as the existing sharks (Elasmobranchii). The first fishes with a gill-cover and with bony tissue in their skeleton occur in the Middle Old Red Sandstone or Middle Devonian; and between these and

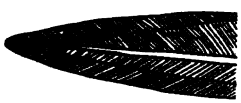


FIG. 57. — Protocercal or diphycercal tail; primitive type.

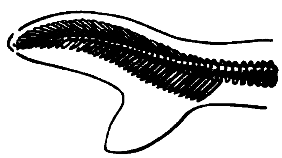


FIG. 58. — Heterocercal (unequal-lobed) tail; middle type.

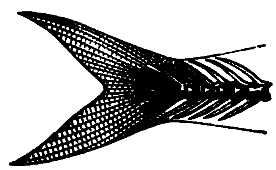


FIG. 59. — Homocercal (equal-lobed) tail; modern type.

modern fishes with a bony internal skeleton there are all gradations in successive geological formations. In the course of evolution it is interesting to observe that the tail undergoes considerable change. In all the older fishes the hinder extremity of the body tapers, and is either straight (Fig. 57) or with the fin almost or completely confined to the lower border (Fig. 58). In later fishes, the upturned end of the body in the unequal-lobed tail is more and more shortened, and the fin-rays gradually become so disposed that to all external appearance the tail assumes perfect symmetry (Fig. 59). Such changes are precisely repeated in the embryonic history of each existing bony fish; so that in the tail the history of the whole race corresponds with the history of each of its latest and highest individuals.

CLASSIFICATION OF FISHES.

SUB-CLASS I.—ELASMOBRANCHII. Jaw-apparatus suspended from skull; no operculum; dermal armour without bone-tissue ..	Elasmobranchii or Chondropterygii.
Order I.—ACANTHODII. All fins except caudal with spine in front, and cartilages very short; no claspers in male	
Order II.—PLEUROPTERYGII. Paired fins supported by parallel rods of cartilage; no claspers in male	
Order III.—ICHTHYOTOMI. Pectoral fins supported by cartilages radiating from central axis; claspers in male	
Order IV.—SELACHII. Pectoral fins with two or three basal cartilages and no central axis; claspers in male	
Sub-orders.—*Asterospondyli* and *Tectospondyli*.	
SUB-CLASS II.—HOLOCEPHALI. Jaw-apparatus fused with skull; an opercular membrane; dermal armour without bone-tissue ..	
Order I.—CHIMÆROIDEI. Fins as in Selachii	
SUB-CLASS III.—DIPNOI. Jaw-apparatus fused with skull; an opercular bone; dermal armour often with bone-tissue	Dipnoi.
Order I.—SIRENOIDEI. Scaly fishes with paddle-shaped paired fins, these supported by a segmented axis	
Order II.—ARTHRODIRA. Armoured fishes, the head-shield hinged on body-shield; paired fins rudimentary	Ganoidei.
SUB-CLASS IV.—TELEOSTOMI. Jaw-apparatus suspended from skull; an opercular bone; dermal armour often with bone-tissue ..	
Order I.—CROSSOPTERYGII. Paired fins paddle-shaped and fringed with fin-rays ..	
Sub-orders.—*Haplistia*, *Rhipidistia*, *Actinistia*, and *Cladistia*	
Order II.—ACTINOPTERYGII. Supports of paired fins much shortened and dermal rays chiefly supporting membrane .. .	
Sub-orders.—*Chondrostei*, *Protospondyli*, *Aetheospondyli*, *Isospondyli* (in part),	
Isospondyli (continued), *Ostariophysi*, *Apodes*, *Anacanthini*, *Percesoces*, *Hemibranchii*, and *Acanthopterygii*.	Teleostei.

The fossil true fishes are arranged in Gallery No. 6 in systematic order according to the above classification, the smaller specimens being in the Table-cases, the larger specimens in the Wall-cases. The series begins with the Elasmobranchii to the left of the door leading from Gallery No. 4.

SUB-CLASS I.—ELASMOBRANCHII.

Most of the fossil remains of sharks, dog-fishes, skates, and their extinct representatives, are very fragmentary, on account of the imperfect hardening of the internal skeleton by lime. In many cases only scattered teeth, spines, and hard skin-tubercles or "shagreen" remain. The detached fin-spines are rarely sufficient to indicate the nature of the fishes to which they originally belonged, and they are only referred to the Elasmobranchii because they have the same microscopic structure as the spines of modern sharks and skates. These fossils are named ICHTHYODORULITES ("fish-spine-stones"), and are arranged in the small Table-case F in the middle of the Gallery. Among them may be specially noticed the small ribbed spines of *Onchus* from the Lower Old Red Sandstone; *Oracanthus* from the Carboniferous Limestone; and *Listracanthus* from the Coal Measures. One of the largest known Ichthyodorulites is *Oracanthus pustulosus*, 26 inches in length, from the Carboniferous Limestone of Bristol, in Wall-case 2. **Table-case F.**

ORDER I.—ACANTHODII.

Wall-case 1. Table-case 1.

The oldest Elasmobranchs are the small Acanthodian fishes, ranging from the Upper Silurian to the Upper Permian. They are completely covered with regularly arranged shagreen, and they often exhibit a ring of plates

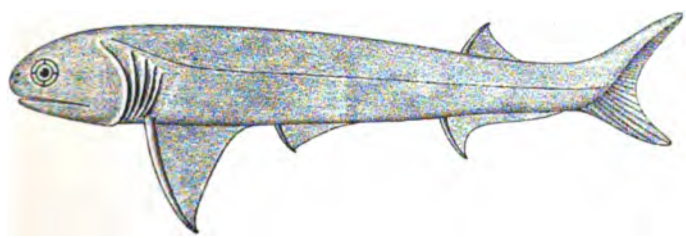


FIG 60.—Restoration of *Acanthodes wardi*, from the Coal Measures of Staffordshire about one-third nat. size. (Table-case 1.)

round the eye. When teeth are present these are firmly fixed to the edge of the jaws. The tail is heterocercal, and each of the other fins is armoured with a spine in front. The Upper Silurian and Lower Devonian Acanthodians

Wall-case 1. Table-case 1. (*Climatius*, *Parexus*, etc.) have comparatively broad fin-spines obviously formed by the fusion of rows of hard tubercles; and there are pairs of these spines on the lower border of the fish between the pectoral and pelvic fins, as if the paired fins had originally been a pair of continuous membranes, afterwards sub-divided. The Middle and

FIG. 61.—Fin-spine of *Gyracanthus formosus*, from the Coal Measures of Dalkeith; about one-third nat. size. (Table-case 1.)

Upper Devonian *Diplacanthus* and the Carboniferous and Permian *Acanthodes* (Fig. 60) are characterised by more slender fin-spines with little or no trace of intermediate paired spines. *Gyracanthus* is a curious Carboniferous genus, comprising comparatively large species, which are scarcely known except by their fin-spines (Fig. 61).

ORDER II.—PLEUROPTERYGII.

Wall-case 1. Table-case 2. Wall-case 1 contains some fine specimens of an Upper Devonian shark, *Cladoselache*, representing another primitive group, in which the teeth are loosely arranged in the jaws as in modern sharks, while the paired fins are mere balancers supported by separate parallel rods of cartilage. As in Acanthodians, there is a ring of plates round the eye. The tail is heterocercal, though it is less conspicuous in the fossils than the horizontal keel of skin which extends along each side of its base. The nearly complete examples of *Cladoselache* have been discovered only in the Cleveland Shale of Ohio, U.S.A., the largest being 5 or 6 feet in length; but the teeth in this fish closely resemble those named *Cladodus*, which are commonly found isolated in the Lower Carboniferous both of America and Europe (Table-case 2), and probably belong to allied genera.

In some of the Palæozoic sharks the piercing or cutting teeth succeeded each other rapidly during life as in existing sharks, but did not fall from the outer edge of the mouth when they were no longer wanted. The used teeth of each transverse row united into an ever-increasing coil outside the

lip, until this phenomenon culminated in the strange spiral known as *Helicoprion* (Fig. 62) from the Permo-Carboniferous of Russia, Japan, and Australia (Table-case 2). **Table-case 2.**

FIG. 62.—Spiral row of teeth of *Helicoprion bessonowi*, from the Permo-Carboniferous of Perm, Russia; one-quarter nat. size. A. new teeth being formed; B. teeth in use; C. old teeth passed out of use. (After A. Karpinsky. Table-case 2.)

Edestus is a nearly similar cluster of teeth from the Carboniferous of North America and Europe. The sharks to which these teeth belonged may have been Pleuropterygii, but their relationships are still uncertain.

ORDER III.—ICHTHYOTOMI.

These are sharks with the paired fins paddle-shaped and supported by a more or less branched arrangement of cartilages like that in the paddles of Dipnoan fishes and Crossopterygii (p. 81). *Pleuracanthus* (Fig. 63) is the typical genus, represented in Table-case 2 by nearly complete fishes from the Lower Permian of Germany and Bohemia, and by spines and teeth (*Diplodus*) from various European and American Carboniferous and Lower Permian rocks. **Table-case 2.**

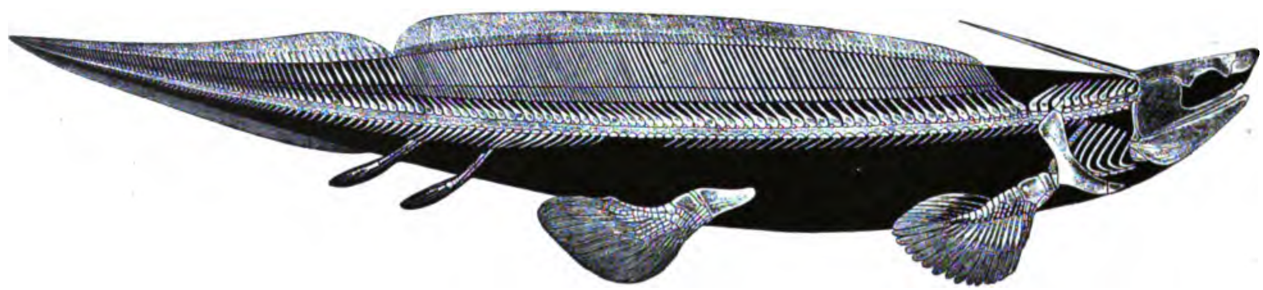


FIG. 63.—Restored skeleton of *Pleuracanthus decheni*, from the Lower Permian of Bohemia; about one-quarter nat. size. (After A. Fritsch, except that the paired fins have been reversed in direction. Table-case 2.)

Each tooth consists of a thick expanded base, bearing a divergent pair of conical cusps at its front edge, usually with an intermediate minute cusp. The slender spine is armed with a double longitudinal row of hook-shaped denticles, and is inserted on the back of the top of the head. The internal skeleton, which is sufficiently hardened with lime to be well preserved, shows that the notochord was not replaced by vertebral bodies. **Table-case 2.**

ORDER IV.—**SELACHII.**

These are the modern sharks and skates, in which the cartilaginous supports of the pectoral fins are fused at the upper end into three (occasionally two) basal pieces, with no branched arrangement, while the pelvic fins are borne on a well-developed pelvis. Vertebral bodies are well formed in most members of the Order. **Wall-cases 2, 3. Table-cases 3–8.**

The Palæozoic representatives of the Selachii are so imperfectly known that they cannot yet be satisfactorily classified. The Carboniferous teeth named *Psammodus* and *Copodus* (Table-case 3) are crushing plates suggestive of those of some of the largest existing skates. **Table-case 3.** The Carboniferous and Permian Petalodontidæ (*Janassa*, *Petalodus*, etc.) are better known, but still of problematical relationships (Table-case 3). The Carboniferous Cochliodontidæ (Table-case 3) seem to have been allied to the existing Port Jackson shark (*Cestracion*), with dorsal fin-spines, and with crushing teeth which fused together into spirals (like *Helicoprion*, p. 65) instead of falling from the mouth when no longer in use. *Cochliodus* (Fig. 64)

FIG. 64.—**Jaw with teeth of *Cochliodus contortus*, from the Carboniferous Limestone of Armagh; one-half nat. size. (Table-case 3.)**

is a typical example, and dental plates of this and allied sharks (*Psephodus, Pœcilodus, Helodus,* etc.) are not uncommon in the Carboniferous Limestone. Large portions of small fishes referable to *Helodus* are exhibited from the Staffordshire Coal Measures (John Ward Collection, Table-case 3).

F 2

Table-cases 4-8. From the Lias onwards it is easy to distinguish the sharks and skates. The former, of the Sub-order **Asterospondyli** ("star-vertebræ"), always exhibit an anal fin, and when the vertebræ are strengthened, radiating plates predominate over concentric plates in their structure. The skates and their allies, of the Sub-order **Tectospondyli** ("covered vertebræ"), are destitute of an anal fin, and their vertebræ, when fully developed, are strengthened by hard concentric layers.

SUB-ORDER 1.—Asterospondyli.

Table-case 6. The Notidanidæ, which are perhaps the most primitive surviving family of sharks, are represented by numerous typical teeth of *Notidanus* from Upper Jurassic, Cretaceous, and Tertiary formations (Table-case 6). It is noteworthy that the largest and most complex teeth (Fig. 65) are those from the

FIG. 65.—Tooth of *Notidanus gigas*, from the Red Crag of Suffolk; nat. size. (Table-case 6.)

Wall-cases 2, 3. Table-cases 4, 5. latest deposits. The Cestraciontidæ are also primitive, and represented only at the present day by the Port Jackson shark *Cestracion* (Figs. 66, 67), which lives on shell-fish, and has crushing teeth on the sides of the jaw with prehensile teeth in front. To this family may probably be referred the Carboniferous sharks, *Sphenacanthus* and *Tristychius*, which have cuspidate teeth and ribbed dorsal fin-spines (Wall-case 2, Table-case 4). The fine teeth of *Orodus* from the Carboniferous Limestone are also probably Cestraciont (Table-case 4). *Hybodus*, ranging from the Muschelkalk to the Wealden, exhibits a persistent notochord, cuspidate teeth, and ribbed dorsal fin-spines (Fig. 68); many specimens, presumably males, are further provided on each side of the head with two large barbed hooklets on a broad base (originally named *Sphenonchus*). The finest specimens of *Hybodus*, exhibited in Wall-case 2 and Table-case 4, were obtained from the Lower Lias of Lyme Regis, Dorset, and the Wealden of Pevensey Bay, Sussex. *Acrodus*, ranging from the Muschelkalk to the

Gault, only differs from *Hybodus* in its blunter teeth (Fig. 69). *Palæospinax*, from the Upper Lias of Würtemberg, is a small allied shark with smooth dorsal fin-spines and with simple vertebræ (Wall-case 3). *Synechodus* from the Chalk is nearly

Table-case 5.

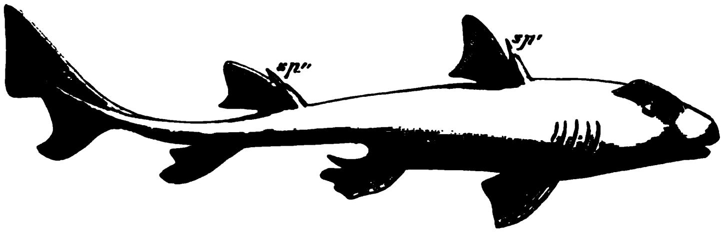


FIG. 66.—The existing Port Jackson Shark (*Cestracion philippi*), from Australian seas; much reduced. *sp'*. anterior dorsal fin-spine; *sp''*. posterior dorsal fin-spine.

FIG. 67. Jaw of Port Jackson Shark (*Cestracion philippi*), showing grasping teeth in front, crushing teeth at the sides. (Table-case 5.)

similar (Table-case 5). *Asteracanthus*, with a dentition commonly named *Strophodus* (Fig. 70), agrees with *Hybodus* and *Acrodus* in most essential respects. As shown by good specimens from the Oxford Clay of Peterborough in Table-case 5, the head was armed with the so-called *Sphenonchus*.

Wall-case 3. Table-case 5.

Cestracion itself ranges from the Upper Jurassic onwards, and there is a well-preserved example in Wall-case 3 from the Upper Jurassic Lithographic Stone of Bavaria.

The Scylliidæ date from Upper Jurassic times, and there are well-preserved specimens of these small dog-fishes from

FIG. 68.—Dorsal fin-spine of *Hybodus*, from the Wealden of Sussex; about two-thirds nat. size. (Table-case 4.)

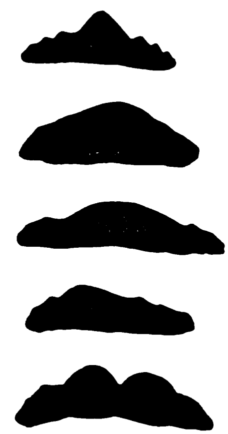


FIG. 69.—Teeth of *Acrodus annin*... showing variation in shape, from the Lower Lias of Lyme Regis nat. size. (Table-case 5.)

Wall-case 3. Table-case 6.

the Lithographic Stone of Bavaria and the Upper Cretaceous of Westphalia and Mount Lebanon in Wall-case 3 and Table-case 6. The Lamnidæ and Carchariidæ are the characteristic sharks of modern times, but are rarely found fossil except in the form of detached teeth, vertebræ, and pieces of cartilage. To the Lamnidæ may be assigned the fine examples of *Scapanorhynchus* from the Upper Cretaceous

of Mount Lebanon in Wall-case 3, this genus being almost identical with *Mitsukurina* now living off Japan. Numerous isolated teeth and groups of teeth of the same family from Cretaceous and Tertiary formations are exhibited in Table- **Wall-case 3. Table-cases 6, 7.**

FIG. 70.—Jaw of *Asteracanthus* (*Strophodus medius*) from the Great Oolite of Caen, Normandy; one-third nat. size. (Table-case 5.)

cases 6, 7, but it is impossible to name them satisfactorily, owing to the variation of shape always occurring in one and the same mouth. The existing genera *Lamna*, *Oxyrhina*, *Odontaspis* (Fig. 71), and *Carcharodon* (Fig. 72), are repre-

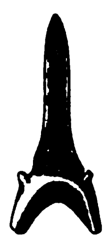


FIG. 71.—Tooth of *Odontaspis elegans*, outer view, from the London Clay of Sheppey; nat. size. (Table-case 6.)

sented. The teeth of the largest extinct species, *Carcharodon megalodon*, have an almost world-wide distribution in Miocene and Pliocene formations; and some examples have been dredged in a semi-fossil state, impregnated with the oxides of iron and manganese, from great depths in the existing oceans (see the "Challenger" dredgings in a middle

Wall-case 3. Table-case 7. Table-case in Gallery 10). The Carchariidæ are almost, if not exclusively, Tertiary, and only a small collection of the

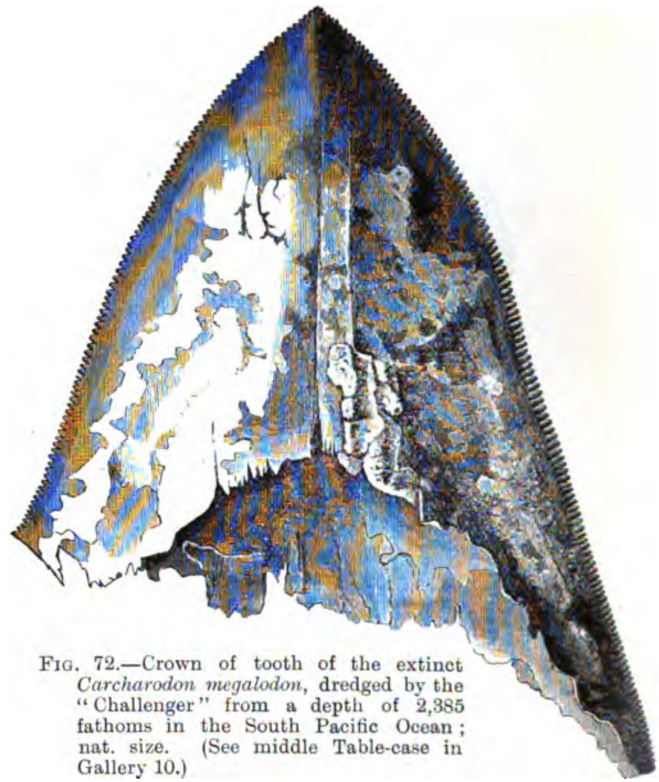


FIG. 72.—Crown of tooth of the extinct *Carcharodon megalodon*, dredged by the "Challenger" from a depth of 2,385 fathoms in the South Pacific Ocean; nat. size. (See middle Table-case in Gallery 10.)

teeth and vertebræ of *Carcharias*, *Galeocerdo*, *Hemipristis*, etc., is exhibited (Table-case 7).

SUB-ORDER 2.—**Tectospondyli.**

Wall-case 3. Table-cases 7, 8. The surviving spiny dog-fishes or Spinacidæ seem most nearly to represent the ancestors of the skates, but they are only known to date back to the Cretaceous period. *Acanthias* and *Centrophorus* are represented by complete fishes in the Upper Cretaceous of Mount Lebanon (Table-case 7). The Pristiophoridæ and Pristidæ are proved to be of similar antiquity. *Sclerorhynchus* from Mount Lebanon is an

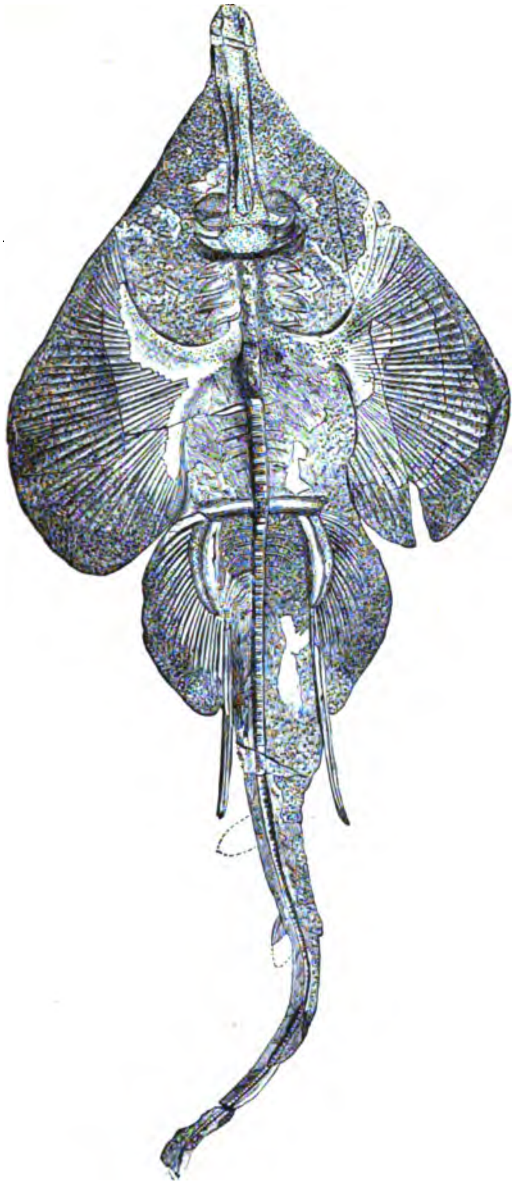


FIG. 73.—A fossil skate (*Rhinobatus bugesiacus*), male, from the Lithographic Stone of Eichstätt, Bavaria; about one-tenth nat. size. (A female specimen is mounted on the wall between Wall-cases 2, 3.)

Wall-case 3. Table-cases 7, 8.

ancestral saw-fish; while teeth and pieces of the saw of *Pristis* itself occur in Eocene deposits (Table-case 7). The

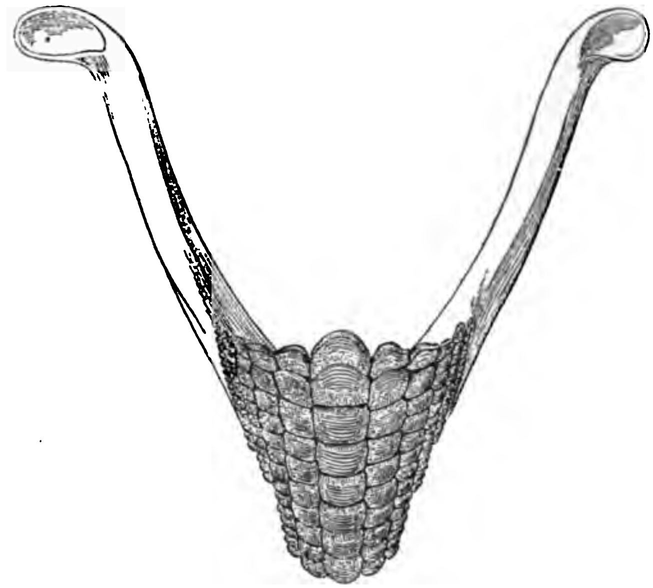


FIG. 74.—Mandible of *Ptychodus decurrens*, from the Lower Chalk of Sussex; reduced. (After A. S. Woodward. Table-case 8.)

Squatinidæ and Rhinobatidæ date back even to the Upper Jurassic; and well-preserved skeletons are exhibited both from the Bavarian and French Lithographic Stone, and from the Upper Cretaceous of Mount Lebanon (Wall-case 3, Table-case 7). The large skeletons of *Rhinobatus bugesiacus* (Fig. 73) and *Squatina acanthoderma*, mounted between Wall-cases 2, 3 and 3, 4, are especially noteworthy as beautifully preserved fossil fishes. Some of the Rajidæ and Trygonidæ are Upper Cretaceous, and the remarkable skeletons of *Cyclobatis* from Mount Lebanon, in Table-

FIG. 75.—Skin-tubercle of the existing Thornback (*Raja clavata*), outer view and side-view, showing the prickle; about nat. size. (Fossil in Red Crag, Table-case 7.)

case 8, are unusually good specimens. The well-known teeth of *Ptychodus* (Fig. 74), from the Chalk, seem to belong to a skate intermediate between these families and the Myliobatidæ or "devil fishes." An extensive collection is exhibited in Table-case 8. Typical portions of the dentition of *Myliobatis* itself occur abundantly in the English Eocenes, but the largest known specimen (*M. pentoni*) is from the Eocene of the Mokattam Hills near Cairo, Egypt (Table-case 8); *Aetobatis* and *Rhinoptera* are also Eocene. Skin-tubercles of the existing *Raja* occur in the Pliocene Crag (Fig. 75).

Wall-case 3. Table-cases 7, 8.

SUB-CLASS II.—HOLOCEPHALI.

The Chimæroids do not differ much from the Elasmobranchs, except in the fusion of the upper jaw-cartilage with the skull; but fossils have not hitherto revealed any fishes definitely intermediate between these two Sub-classes.

Wall-case 3. Table-case 9.

FIG. 76.—Left mandibular tooth of *Edaphodon leptognathus*, inner view, from the Middle Eocene of Bracklesham Bay, Sussex; about two-thirds nat. size. (Table-case 9.)

The teeth are large and reduced to not more than two pairs in the upper jaw and one pair in the lower jaw, while the whole dentition is shaped much like a beak.

Typical Chimæroid teeth, *Rhynchodus* and *Ptyctodus*, are found in the Devonian of North America and Europe; but some isolated teeth of this age are so peculiar that they may be either Chimæroid, Sirenoid (p. 76) or Arthrodiran (p. 79). The first satisfactory skeletons are those of the Jurassic period, and some are exhibited in Wall-case 3. The skeletons of *Squaloraja*, from the Lower Lias of Lyme Regis, are especially well preserved, and prove this fish to have been shaped like a narrow skate, with a long snout and a long tapering frontal spine in the male, but no dorsal fin-spine. *Myriacanthus*, from the same formation and locality, resembles

Wall-case 3. Table-case 9.

the existing *Callorhynchus* in the shape of its snout, but is peculiar in having a supplementary chisel-shaped tooth in front of the lower jaw. The still-surviving family of Chimæridæ is first represented by teeth of *Ganodus* and *Ischyodus* in the Lower Oolites (Table-case 9), the latter genus also ranging to the Upper Cretaceous. Good skeletons of *Ischyodus* are known from the Lithographic Stone of Bavaria, and part of one is exhibited in Wall-case 3. Some of the teeth of *Ischyodus* and of the Cretaceous and Eocene *Edaphodon* (Fig. 76) indicate species which must have been gigantic compared with any Chimæroid now living. *Chimæra* itself dates back at least to the Pliocene.

SUB-CLASS III.—DIPNOI.

Wall-case 5. Table-case 10.

The first ordinary fishes with a gill-cover and bony tissue in their skeletons are found in the Middle Old Red Sandstone. They have enamelled bony scales and external head-bones, but very little hardening of the internal cartilaginous skeleton. Their paired fins are paddle-shaped, with an internal skeleton of cartilage; and their tail is always diphycercal or heterocercal (see p. 61). Among these fishes one group is remarkable for the fusion of the upper jaw with the skull, as in Chimæroids and land vertebrates; and this peculiarity is combined with others suggesting that the group in question is connected in some way with the ancestors of the land vertebrates which must have been living in the Devonian period. The survivors of this group are provided not only with the ordinary gills but also with an air-bladder so modified that it can be used as a lung. The Sub-class they represent is therefore known as that of the Dipnoi ("double-breathers").

ORDER I.—**SIRENOIDEI.**

Wall-case 5. Table-case 10.

The living Dipnoi are confined to the widely-separated fresh-waters of South America (*Lepidosiren*), Africa (*Protopterus*), and Australia (*Ceratodus*). In past geological times the Order to which they belong was cosmopolitan. The earliest known genus is *Dipterus* (Figs. 77, 78, 1), of which good specimens from the Caithness flagstones are shown in Table-case 10. It is characterised by two dorsal fins (hence

its name), a heterocercal tail, and beautifully enamelled head-bones and scales. *Phaneropleuron*, with thin scales, occurs in the yellow Upper Old Red Sandstone of Dura Den, Fife-

Wall-case 5. Table-case 10.

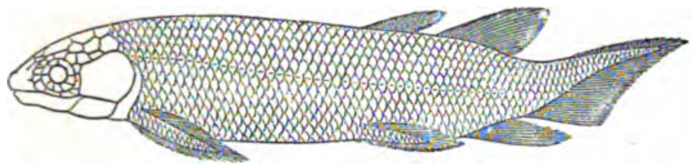


FIG. 77.—Restoration of *Dipterus valenciennesi*, from the Middle Old Red Sandstone of Scotland; one-fifth nat. size. (After R. H. Traquair. Table-case 10.)

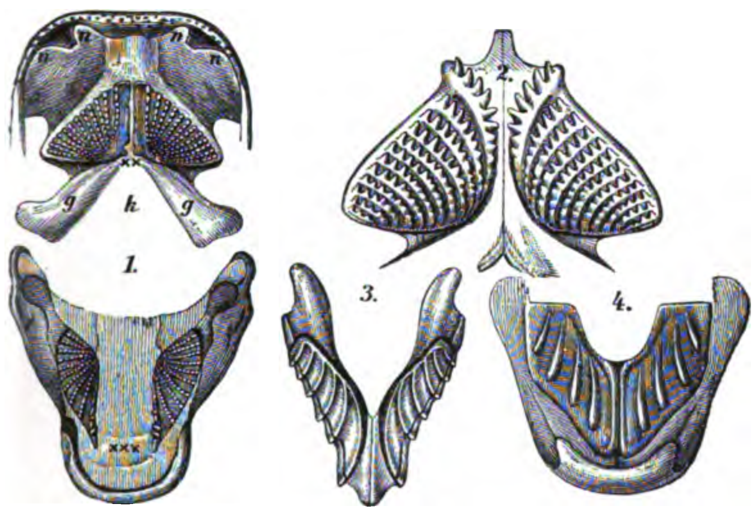


FIG. 78.—TEETH OF PALÆOZOIC DIPNOI. 1. Upper and lower jaws of *Dipterus valenciennesi*, from the Middle Old Red Sandstone of Scotland; nat. size. *xx*. upper teeth or dental plates; *xxx*. lower ditto; *g*. upper tooth-bearing bones; *n*. narial openings. 2. Lower teeth or dental plates of *Ctenodus cristatus* (bone wrongly drawn), from the Coal Measures; one-third nat. size. 3. Lower jaw of *Sagenodus inæqualis*, showing teeth, from the Coal Measures; one-half nat. size. 4. Part of lower jaw of *Palædaphus insignis*, with teeth, from the Upper Devonian of Belgium; one-sixth nat. size. (Table-case 10.)

shire (Wall-case 5), and *Scaumenacia* in the Upper Devonian of Canada (Table-case 10). *Ctenodus* (Fig. 78, 2) and *Sagenodus* (Fig. 78, 3) comprise large fishes known chiefly by fragments from the Carboniferous and Lower Permian of

Wall-case 5. Table-case 10.

Europe, North America, and Australia. All these early genera differ from the existing Dipnoi in having more numerous bones in the roof of their skull. Teeth identical with those of the existing Australian *Ceratodus* (Figs. 79, 80) are known from the Trias and Rhætic of Europe, India and South Africa; from the Jurassic of Europe, North America, and Australia; and from the Cretaceous of Pata-

Fig. 79.—The existing Australian Mud-fish (*Ceratodus forsteri*), from rivers in Queensland; much reduced in size.

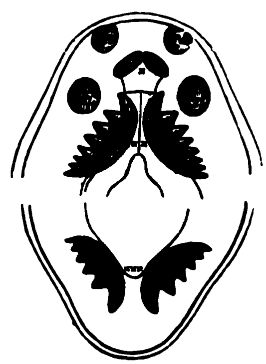


Fig. 80.—Mouth of *Ceratodus forsteri*; about one-half nat. size. *n.n.* narial openings; *x.* vomerine teeth; *xx.* palato-pterygoid teeth; *xxx.* mandibular teeth.

gonia and Northern Africa. A skull which is more extensively ossified and otherwise slightly different from that of the existing *Ceratodus* was obtained by the Geological Survey of Austria from the Rhætic of that country. A typical collection of teeth from the Rhætic of Aust Cliff, near Bristol, and from the Trias of England, Würtemberg, India, and South Africa, is exhibited in Table-case 10.

ORDER II.—ARTHRODIRA.

During the Devonian period there flourished a race of armoured fishes, which exhibit some resemblance to the true Dipnoi in their teeth and appear to have agreed with the **Wall-case 4. Table-cases G-K.**

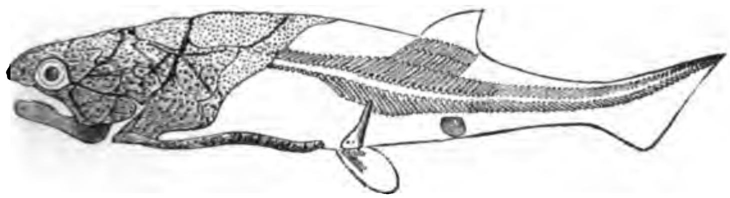


FIG. 81.—Restoration of *Coccosteus decipiens*, left side-view, from the Middle Old Red Sandstone of Scotland; about one-quarter nat. size. (After A. S. Woodward. Wall-case 4.)

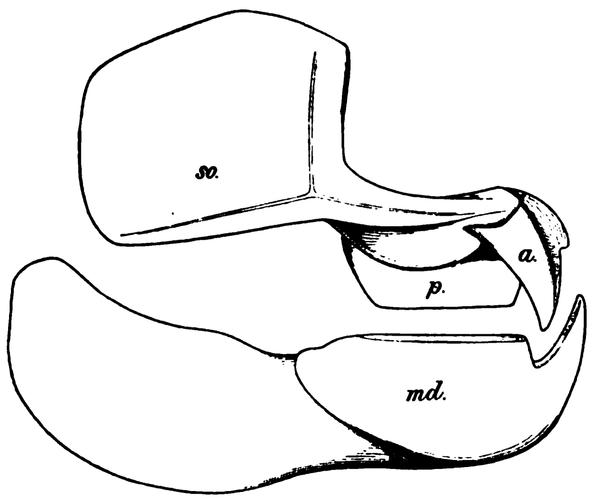


FIG. 82.—Jaws of *Dinichthys intermedius*, right side, outer view, from the Upper Devonian of Ohio; one-third nat. size. *a.* anterior upper piercing plate; *md.* mandible; *p.* posterior upper cutting plate; *so.* suborbital bone, showing groove for slime-canal. (Wall-case 4.)

latter in the fusion of the upper jaw with the skull. The armour of their head is movably articulated with that of the trunk by means of a pair of well-formed ball-and-socket joints, and hence they are named Arthrodira ("joint-necked").

Wall-case 4. Table-cases G–K.

Their remains occupy Wall-case 4, and the characteristically jointed neck is especially well seen in two mounted skulls of *Dinichthys.*

Coccosteus (Fig. 81), which attains a maximum length of about two feet, is the best known Arthrodiran, and is represented by a fine series of specimens from the Middle Old Red Sandstone of Scotland. All the armour-plates are

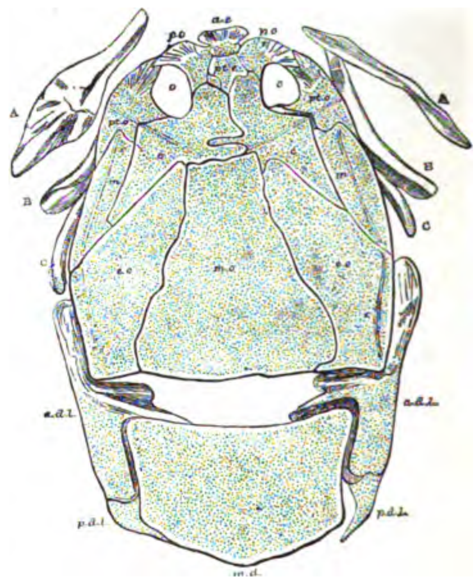


Fig. 83.—Upper view of armour of *Homosteus milleri*, from the Middle Old Red Sandstone of Caithness; one-sixth nat. size. A. B. C. undetermined bones; *a.d.l.* anterior dorso-lateral; *a.e.* ethmoid; *c.* central; *e.o.* external occipital; *m.* marginal; *m.d.* median dorsal; *m.o.* median occipital; *o.* orbit; *p.d.l.* posterior dorso-lateral; *p.o.* pre-orbital; *pt.e.* pineal; *pt.o.* post-orbital. The double lines indicate the course of the slime-canals. (After R. H. Traquair. Wall between Wall-cases 4, 5.)

deeply overlapping, but those of the trunk are confined to its front part just behind the head. The slightly hardened spines above and below the space which would originally be occupied by the notochord, as also the supports of the membranous dorsal fin, are seen in the naked trunk. There are plates which might have supported pectoral fins if such were present; and there are distinct remnants of a pair of posterior or pelvic fins. *Dinichthys* and its allies are large

and even gigantic *Coccosteus*-like fishes from the Upper Devonian of North America. The head sometimes measures 3 or 4 feet across, and one fragment of head-bone exhibited is nearly 4 inches in thickness. The teeth (Fig. 82) form powerful shears and pincers. The large collection of remains of *Dinichthys*, *Gorgonichthys*, *Titanichthys*, and allied genera in Wall-case 4 and Table-cases G to K was obtained by Dr. William Clark from the Cleveland Shale of Ohio. **Wall-case 4.**

Homosteus (Hugh Miller's "Asterolepis of Stromness") is another Arthrodiran of moderate size with thin armour, from the Middle Old Red Sandstone of Caithness, Orkney, and Russia, and is represented by plaster casts of fine specimens between Wall-cases 4, 5 (Fig. 83). *Heterosteus* is a gigantic allied fish, of which massive fragments from Russia are shown in Wall-case 4.

Phlyctænaspis is the earliest and smallest Arthrodiran, from the Lower Devonian of England, Galicia, and Canada (Table-case G).

SUB-CLASS IV.—TELEOSTOMI.

These are fishes with a bony armour or bony skeleton, or both; with a bony operculum covering the gill-cavity; and with the more or less hardened cartilages of the upper jaw not fused with the skull, but suspended from it behind. They are named Teleostomi ("complete mouth") because external or membrane bones form a complete border to the jaws. They comprise the immense majority of known fishes.

ORDER I.—CROSSOPTERYGII.

Most of the early paddle-finned fishes already mentioned on p. 76 have their upper jaw suspended as just described, and may thus be regarded as the direct forerunners of the bony fishes proper. They are named Crossopterygii ("fringe-finned") because their paddles are fringed with delicate filaments or fin-rays in the bordering skin. **Wall-cases 5–7. Table-cases 11, 12.**

The fringe-finned ganoids are now almost extinct, being represented only in the freshwaters of Africa by *Polypterus* and *Calamoichthys*. In the Devonian and Carboniferous periods they existed in large numbers and great variety, and were distributed nearly all over the world. *Holoptychius* (Fig. 84) is a well-known Devonian genus represented in the

Wall-cases 5–7. Table-cases 11, 12.

collection by fine specimens from the Old Red Sandstone of Scotland (Wall-case 5), and by more fragmentary remains from England, Russia, North America, and Greenland (Table-case 11). Its pectoral fins are as acutely lobate as in

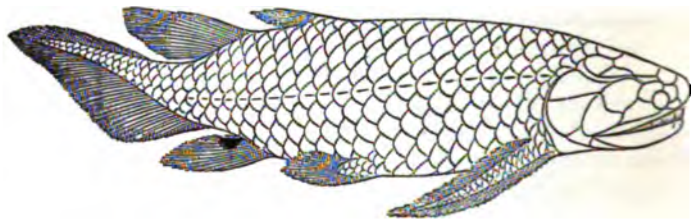


FIG. 84.—Restoration of *Holoptychius flemingi*, from the Upper Old Red Sandstone of Dura Den, Fifeshire; one-eighth nat. size. (After R. H. Traquair. Wall-case 5.)

Ceratodus, and its large overlapping scales are rounded, with a wrinkled ornamentation. Its teeth, as shown in transverse section (Fig. 85), are of a very complex structure, much resembling that observable in the teeth of Labyrinthodonts

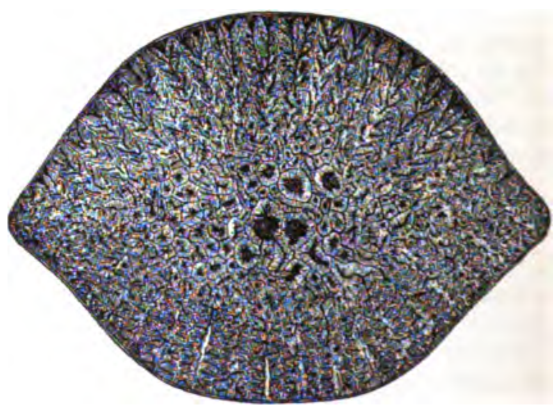


FIG. 85.—Transverse section of tooth of *Holoptychius*, showing complicated "dendrodont" structure; much enlarged. (After C. H. Pander.)

(p. 47). This fish lived in shoals which were sometimes suddenly destroyed and buried, as shown by a remarkable slab of Old Red Sandstone from Dura Den, Fifeshire, framed between Wall-cases 5, 6. *Osteolepis* (Fig. 86), *Diplopterus*,

Thursius, and *Glyptolæmus* are Devonian Crossopterygians with obtusely lobate pectoral fins, rhombic scales, and teeth of simpler structure (Wall-case 6, Table-case 11). *Megalichthys*, also with rhombic enamelled scales, comprises some relatively large species of Carboniferous and Lower Permian age, and its remains are among the commonest fossils of the

Wall-cases 5–7. Table-cases 11, 12.

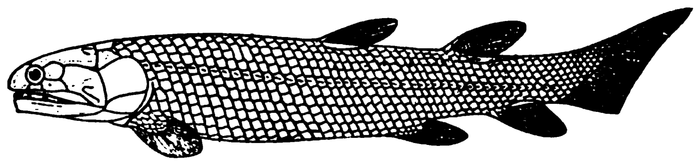


FIG. 86.—Restoration of *Osteolepis macrolepidotus*, from the Middle Old Red Sandstone of Scotland; one-third nat. size. (After R. H. Traquair. Wall-case 6.)

English Coal Measures (Wall-case 6, Table-case 11). *Rhizodus* is a still larger fish with deeply-overlapping round scales, from the Lower Carboniferous. Some of the large teeth and jaws of *Rhizodus hibberti* from the Lower Carboniferous of Scotland in Wall-case 6 probably belong to fishes 9 or 10 feet in length. *Strepsodus* (Fig. 87) and *Rhizodopsis* are allied genera, whose teeth and scales are common coal fossils.

The Cœlacanthidæ ("hollow-spined") are the most remarkable Crossopterygians, ranging almost unchanged from the Upper Devonian to the Upper Chalk (Wall-case 7, Table-case 12). Their name refers to the circumstance that the spines of the backbone are only superficially ossified and so appear hollow when fossilised. Their general appearance is shown by the accompanying drawing of *Undina* (Fig. 88), which is represented in Table-case 12 by fine specimens from the Upper Jurassic Lithographic Stone of Bavaria, and from the Lower Lias of England. The large air-bladder seen beneath the backbone in many specimens, especially in those from the Chalk, has a thin bony wall, as in some existing fresh-

Wall-case 7. Table-case 12.

FIG. 87.—Tooth of *Strepsodus sauroides*, from the English Coal Measures; nat. size. (Table-case 11.)

Wall-case 7. Table-case 12. water teleosteans. *Cœlacanthus* is Carboniferous and Permian; *Undina* is always Jurassic; *Macropoma* is Cretaceous,

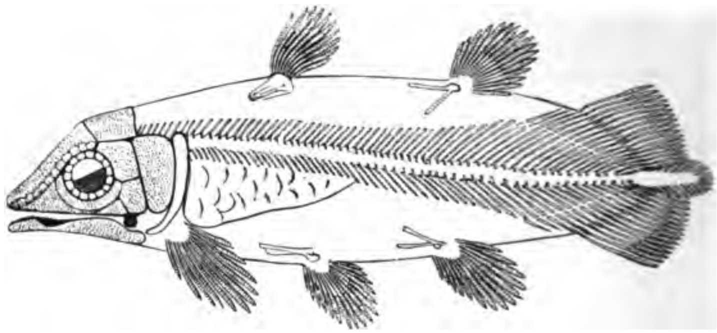


FIG. 88.—Restoration of *Undina* (*Holophagus*) *gulo*, from the Lower Lias of Lyme Regis; about one-seventh nat. size. (After A. S. Woodward. Wall-case 7 and Table-case 12.)

and is represented in Wall-case 7 by the unique collection of Dr. Gideon Mantell, besides later acquisitions from the English Chalk.

ORDER II.—ACTINOPTERYGII.

Paddle-like fins may be effective for a sluggish life in shallow waters and marshes, but they are less well adapted for active swimming away from the shore. Progress in the direction of modern fishes therefore only became rapid when the fins lost their basal lobe and became light flexible flaps of membrane stiffened merely by delicate filaments or fin-rays. Thus arose the highest grade of fish-life, known as that of the Actinopterygii ("ray-finned").

SUB-ORDER 1.—Chondrostei.

Wall-cases 7, 8. Table-cases 13-16. The earliest Actinopterygians still resembled the Crossopterygians of the same period in the excessive hardening of the external skeleton, in the heterocercal condition of the tail, and in the circumstance that the rays of the median fins were more numerous than the pieces of cartilage fixed in the flesh to support them. So long as fishes retained this combination of characters their internal skeleton never progressed, and they eventually terminated in the existing

degenerate sturgeons (Fig. 94). Such fishes are appropriately named Chondrostei ("gristle-boned").

The earliest Chondrosteans are the Palæoniscidæ, which are rapacious fishes with complete jaws, well-formed external head-bones, and usually a regular covering of enamelled rhombic scales, united by peg-and-socket joints (Fig. 89). **Wall-case 8. Table-cases 13-15.**

Cheirolepis is their oldest known representative, from the Middle Old Red Sandstone of Scotland and the Upper Devonian of Canada (Wall-case 8), but they are specially characteristic of Carboniferous and Permian formations. *Palæoniscus* itself (Fig. 90) is Upper Permian (Table-case 14). *Elonichthys, Rhadinichthys,* and *Gonatodus* are the commonest Carboniferous genera; *Acrolepis, Amblypterus,* and *Pygopterus* occur with *Palæoniscus* in the Permian; *Gyrolepis* is Triassic, and *Atherstonia* is abundant in the Karoo Formation of South Africa (Table-case 15); *Oxygnathus* and *Platysiagum* are Liassic (Wall-case 8); and *Coccolepis* ranges from the Lias to the Purbeck Beds (Table-case 15).

FIG. 89.—Ganoid scales of *Elonichthys striatus*, outer view (*a*) and inner face (*b*), from the Lower Carboniferous of Scotland; nat. size. The inner face shows the peg-and-socket articulation.

The Platysomidæ are deep-bodied fishes with stumpy teeth, closely related to the Palæoniscidæ, but confined to Carboniferous and Permian rocks. *Eurynotus* (Fig. 91) is Lower Carboniferous, while *Platysomus* (Fig. 92) is both Carboniferous and Permian. **Wall-case 8. Table-cases 15, 16.**

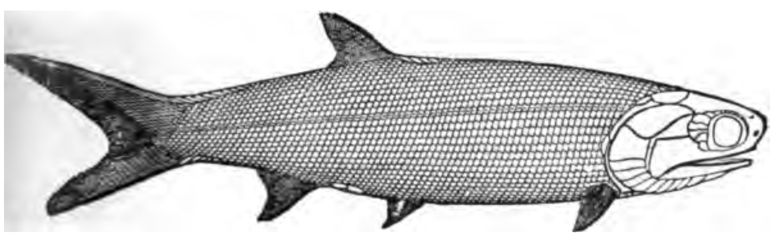


FIG. 90.—Restoration of *Palæoniscus macropomus*, from the Upper Permian of Germany; nearly one-half nat. size. (After R. H. Traquair. Table-case 14.)

The Catopteridæ are small Triassic Chondrosteans in which

Wall-case 8. Table-case 16.

the upper lobe of the tail is much shortened and the rays of the dorsal and anal fins are nearly as few as their supporting cartilages. They are therefore intermediate between the

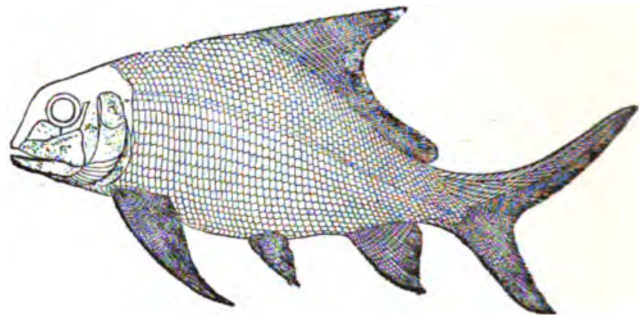


FIG. 91.—Restoration of *Eurynotus crenatus*, from the Lower Carboniferous of Scotland; about one-quarter nat. size. (After R. H. Traquair. Table-case 15.)

Chondrostei and the next higher sub-order of fishes. They are represented by *Catopterus* from North America, and by *Dictyopyge* from Europe, North America, and Australia.

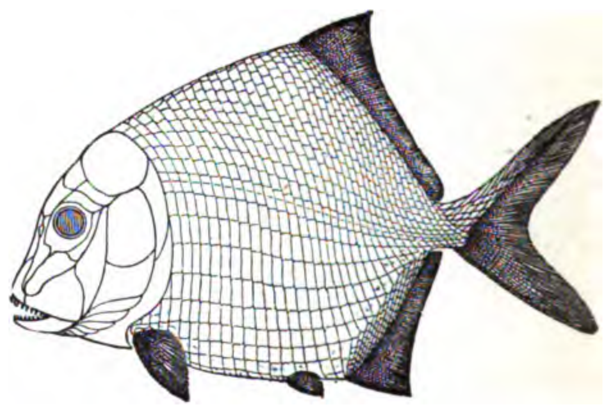


FIG. 92.—Restoration of *Platysomus striatus*, from the Upper Permian of Germany and N. England; about one-quarter nat. size. (After R. H. Traquair. Table-case 15 and Wall-case 8.)

Table-case 16.

The Triassic and Liassic Belonorhynchidæ seem to be elongated and degenerate Chondrosteans. As shown by *Belonorhynchus*, of which good specimens are exhibited in

ORDER—**Actinopterygii.** SUB-ORDER—**Chondrostei.**

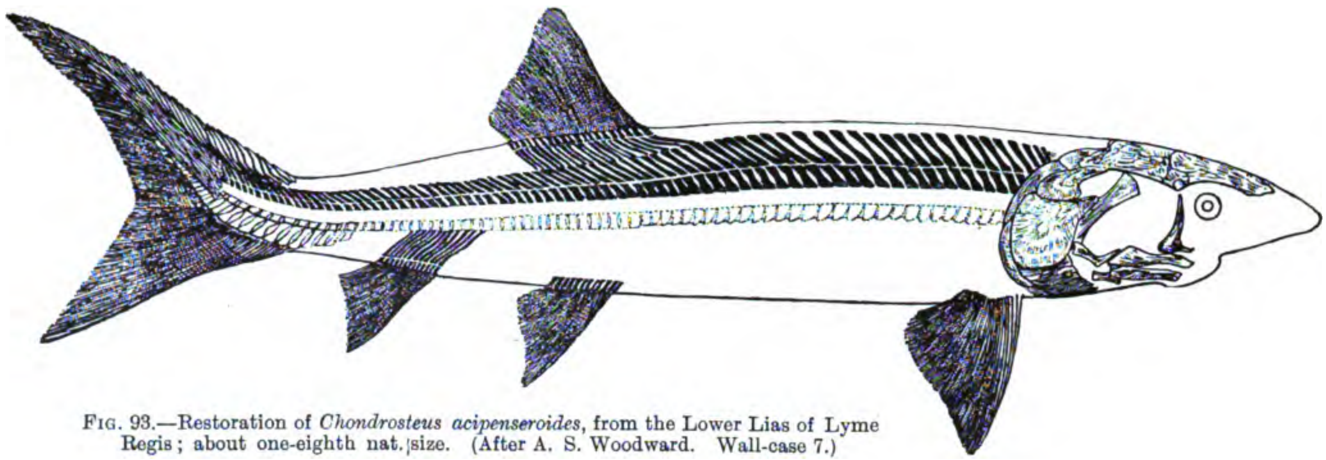


FIG. 93.—Restoration of *Chondrosteus acipenseroides*, from the Lower Lias of Lyme Regis; about one-eighth nat. size. (After A. S. Woodward. Wall-case 7.)

ORDER—**Actinopterygii.** SUB-ORDER—**Chondrostei.**

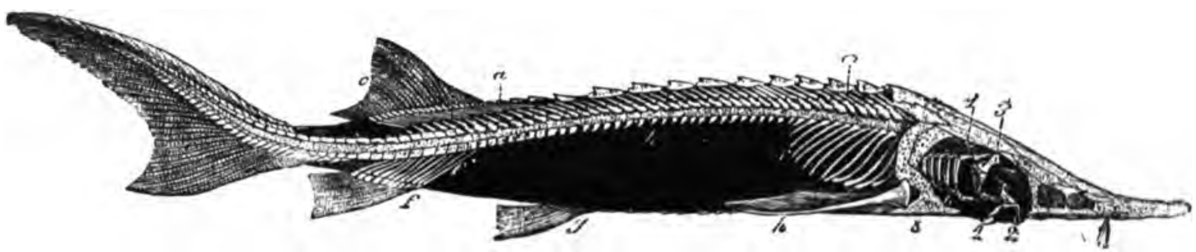


FIG. 94.—Skeleton of existing Sturgeon (*Acipenser*). 1. posterior extremity of cartilaginous cranium beneath the head plates; 2. upper jaw; 3. hyomandibular bone; 4. lower jaw; 6. gill-arches; 8. pectoral arch; *a.* neural arches and spines, placed above the notochord; *b.* hæmal arches, placed below the notochord; *c.* dorsal fin; *e.* caudal fin; *f.* anal fin; *g.* pair of pelvic fins; *h.* pair of pectoral fins; *r.* ribs.

Table-case 16, their snout is long and pointed, their tail is diphycercal (see p. 61), and their trunk is armoured with only four longitudinal rows of bony plates or scutes. The common Rhætic teeth named *Saurichthys* seem to belong to fishes of this family. Table-case 16.

The Chondrosteidæ, represented by *Chondrosteus* (Fig. 93) from the Lower Lias of Lyme Regis, perhaps also by the gigantic *Gyrosteus* from the Upper Lias of Whitby, are intermediate between the Palæoniscidæ and the modern sturgeons. The fine specimens exhibited show that the internal skeleton is identical with that of the sturgeons (Fig. 94), and that the jaws are reduced and toothless; but the roof of the skull and the development of the rays below the gill-cover more closely resemble the corresponding parts in Palæoniscids. Wall-case 7.

A few dermal scutes identical with those of the existing sturgeon, *Acipenser*, are shown from the English Eocene. There are also pectoral fin-spines from both the Eocene and the Pliocene (Table-case 16).

SUB-ORDER 2.—**Protospondyli.**

So soon as the rays of the dorsal and anal fins had become equal in number to their supports, and so soon as the upper lobe of the tail had been permanently reduced to an insignificant stump, fishes began to advance in the hardening or ossification of their internal head-bones and in the acquisition of a well-formed back-bone. Each vertebral body originally began as four separate pieces surrounding the notochord, the upper and lower pairs first uniting into crescents, and these two again fusing into a complete ring. The most characteristic fishes of the Triassic, Rhætic, Jurassic, and Lower Cretaceous periods were in this condition. They form the sub-order Protospondyli ("first vertebræ"), and their sole survivor at the present day is the "bow-fin" or *Amia* of North American lakes and rivers. They are represented in the collection by a very extensive series of fine specimens, those from the English Lias and Wealden and from the Bavarian Lithographic Stone being especially noteworthy. Wall-cases 9-14. Table-cases 16-21.

The first family is that of the Semionotidæ, already represented by one genus of small fishes, *Acentrophorus*, in the Upper Permian. They are stout-bodied, with a small mouth and blunt, often powerfully crushing, teeth. *Semionotus* and *Colobodus* are Triassic and Rhætic; *Dapedius* (Fig. 95) is Wall-cases 9-11. Table-cases 16, 17.

Wall-cases 9-11. Table-cases 16, 17.

Liassic; and *Lepidotus* (Fig. 96) ranges from the Rhætic to the Wealden. The powerful dentition of *Lepidotus*, originally named *Sphærodus*, is particularly noteworthy; the successional teeth when first formed in the jaw being directed away from

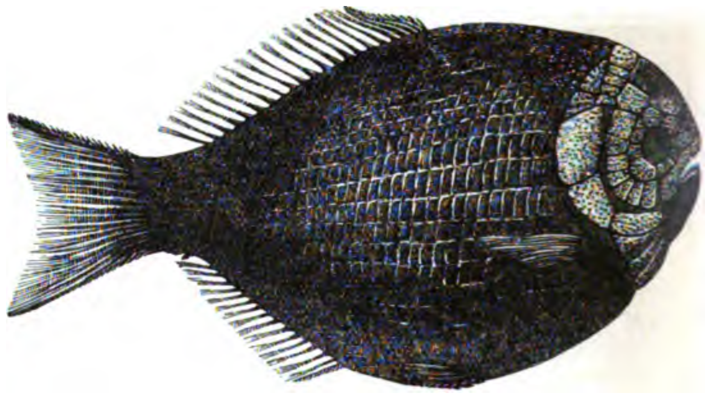


FIG. 95.—*Dapedius politus*, from the Lower Lias of Lyme Regis; one-quarter nat. size. (Wall-case 10.)

those they are destined to replace, and gradually turning through an angle of 180° as they come into use (see specimens in Table-case 16).

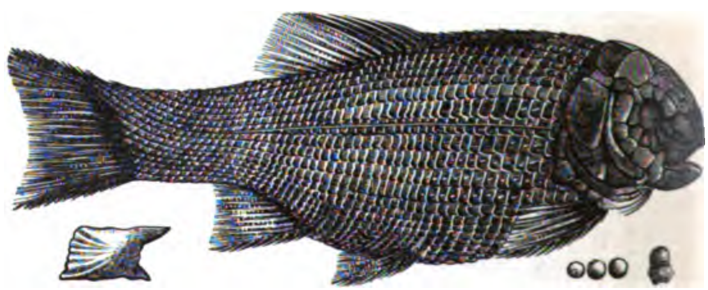


FIG. 96.—*Lepidotus mantelli*, from the Wealden of Sussex; one-tenth nat. size. A scale and some crushing teeth, less reduced, below. (Wall-case 9.)

Wall-case 11. Table-case 17.

The Macrosemiidæ are elongated fishes with small mouth, obtuse teeth, and extended dorsal fin, ranging from the Rhætic to the Chalk. Good examples of *Ophiopsis* and *Macrosemius* are shown from the Lithographic Stone of

Bavaria and France, others of *Ophiopsis* and *Histionotus* from the Purbeck Stone of Dorsetshire and Wiltshire.

The Pycnodontidæ ("thick-toothed") are a remarkable family of deep-bodied fishes, so-called in allusion to the powerful grinding teeth (Fig. 97) which arm their forwardly-displaced mouth. The rhombic scales are usually so thin that their ribbed front margin is often the only part preserved, producing the appearance of a series of parallel streaks from the upper to the lower margin of the trunk. In **Wall-case 11. Table-cases 18, 19.**

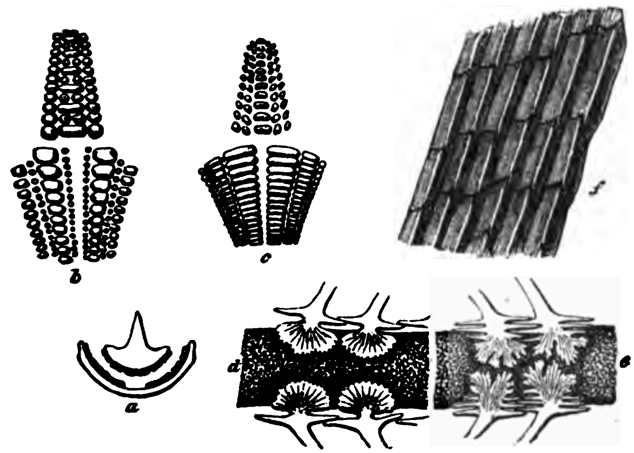


FIG. 97.—Parts of the skeleton of Pycnodont Fishes. *a.* transverse section of jaws, showing the two halves of the mandibular dentition opposing the vomerine teeth; *b.* vomerine and mandibular teeth of *Microdon*; *c.* vomerine and mandibular teeth of *Cœlodus*; *d.* portion of vertebral column of *Cœlodus*, showing persistent notochord (shaded) and the expanded bases of the arches; *e.* the same of *Pycnodus*; *f.* inner view of scales, showing mode of interlocking by pegs and sockets, which are continued as longitudinal ribs. (After J. J. Heckel.)

several genera (*e.g.*, *Mesodon*, *Microdon*, and *Cœlodus*) the tail is destitute of scales. These fishes range from the Lower Lias (*Mesodon liassicus*) to the Upper Eocene (*Pycnodus platessus*) with very little modification. The fine series of examples of *Gyrodus* from the Lithographic Stone of Bavaria, and of *Palæobalistum* from the Hard Chalk of Mount Lebanon, are particularly worthy of attention. The armoured *Coccodus* and *Xenopholis* from Mount Lebanon are also remarkable. None of these fishes have vertebræ, but in the later genera the arches above and below the notochord are often expanded to unite at the sides (Fig. 97, *e*).

Wall-cases 12, 13. Table-cases 19, 20.

The Eugnathidæ are the rhombic-scaled forerunners of the modern *Amia*, and range from the Upper Trias or Rhætic to the Chalk. They are predaceous fishes with a large mouth and conical teeth. Both the thick-scaled *Eugnathus* (Fig. 98) and the thin-scaled *Caturus* (Fig. 99) range

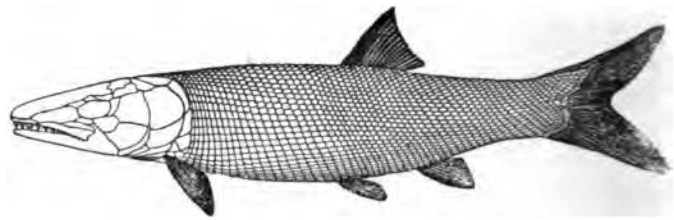


Fig. 98.—Restoration of *Eugnathus orthostomus*, from the Lower Lias of Lyme Regis: about one-seventh nat. size. (After A. S. Woodward. Wall-case 12.)

throughout the Jurassic; and there are allied fishes connecting these with the Amiidæ, which are first typically represented in the Upper Jurassic. *Megalurus* from the German and French Lithographic Stone only differs from *Amia* in its shorter dorsal fin. In the Lower Tertiaries *Amia* itself is as abundantly represented in Europe as in North America.

Table-case 20.

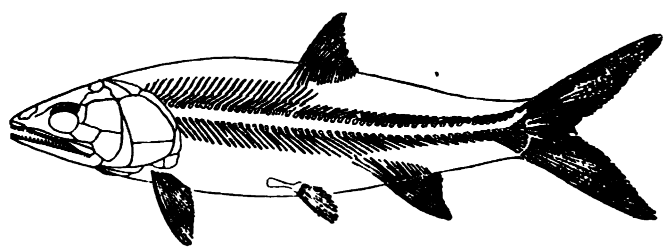


Fig. 99.—Restoration of *Caturus furcatus*, scales omitted, from the Upper Jurassic Lithographic Stone of Bavaria; about one-eleventh nat. size. (After A. S. Woodward. Wall-case 13.)

Good specimens are shown from the Lower Miocene of France, and there are fragments from the Hampshire Basin (Table-case 20).

Wall-case 13. Table-cases 20, 21.

The Pachycormidæ are a family of Amioids which curiously mimic the modern sword-fishes, and range throughout the Jurassic and Cretaceous periods. They are typically represented by *Pachycormus* (Upper Lias), *Hypsocormus* (Upper

Jurassic, Fig. 100), and *Protosphyræna* (Upper Cretaceous). The notochord is never much replaced by vertebral bodies, but to strengthen the trunk the vertebral arches are multiplied and very closely arranged; the powerful forked tail is supported by one fan-shaped lower vertebral arch; and the snout

Wall-case 13. Table-case 21.

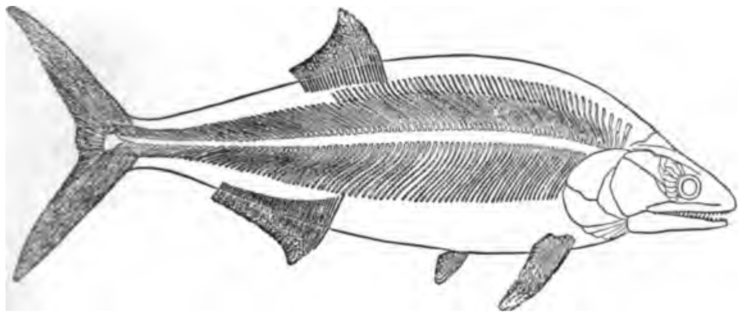


Fig. 100.—Restoration of *Hypsocormus insignis*, scales omitted, from the Upper Jurassic Lithographic Stone of Bavaria; about one-eighth nat. size. (After A. S. Woodward. Wall-case 13.)

gradually becomes elongated until it is a formidable weapon in *Protosphyræna*. The gigantic *Leedsia problematica*, from the Oxford Clay of Peterborough, seems to belong to this family. Its tail, mounted between Wall-cases 13–14, has a span of 9 feet, and probably represents a fish 30 feet in length.

SUB-ORDER 3.—**Aetheospondyli.**

These fishes are ganoids resembling the Protospondyli except that their vertebral rings or bodies do not appear to

Wall-case 14. Table-case 21.

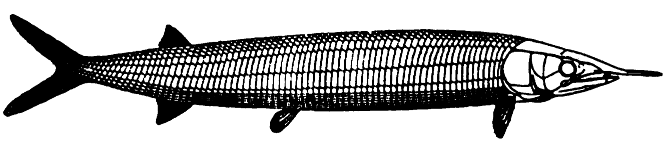


Fig. 101.—Restoration of *Aspidorhynchus acutirostris*, from the Upper Jurassic Lithographic Stone of Bavaria; about one-eleventh nat. size. (After A. S. Woodward. Wall-case 14.)

result from the fusion of once-separate crescentic pieces. *Aspidorhynchus* (Fig. 101), with constricted ring-vertebræ, is represented in Wall-case 14 by a fine series of specimens

Wall-case 14. Table-case 21. from the Lithographic Stone of Bavaria; while the closely related *Belonostomus* is both Upper Jurassic and Cretaceous (Table-case 21). Remains of species of the existing American genus *Lepidosteus*, or "bony pikes," are found in the Lower Tertiaries of Europe, and many of the characteristic concavo-convex vertebræ, with scales, are exhibited from the Upper Eocene of Hordwell, Hampshire.

All the preceding fishes have a complex lower jaw, each half consisting of at least four or five pieces; and when the teeth are powerful, those on the inner (or splenial) element are specially well-developed. In the following groups, on the other hand, the lower jaw consists normally of only two pieces on each side, one behind (articulo-angular) and a larger piece (dentary) in front.

SUB-ORDER 4.—**Isospondyli.**

Wall-cases 15, 16. Table-cases 22-28. In the first and earliest group of the higher fishes the vertebræ never fuse into a complex behind the head, the simple air bladder is directly connected with the gullet, and the pelvic fins are always situated well behind the pectorals. Here may be placed the Pholidophoridæ, which are remarkably like the herrings in general aspect, but have ganoid scales, fulcra on all the fins, and only ring-vertebræ. *Pholidophorus* itself ranges from the Rhætic Table-case 22. to the Purbeck Beds, but is especially well represented by a large series of specimens from the Lower Lias of Lyme Regis. Some diminutive fishes of the genera *Peltopleurus* (Upper Trias) and *Pleuropholis* (Kimmeridgian and Purbeckian) exhibit a series of remarkably deepened scales Wall-case 15. Table-cases 23, 24. on the flank. The Oligopleuridæ, ranging from the Upper Jurassic to the Upper Cretaceous, come next. The Leptolepidæ follow, with *Leptolepis*, *Aethalion*, and *Thrissops*, mostly from the Lithographic Stone of Bavaria; and these differ from the herrings (Clupeidæ) chiefly in the meeting of the parietal bones and in the simple character of the tail. *Leptolepis* (Fig. 102) is first represented by small species in the Upper Lias of England, France and Würtemberg.

Either here or immediately after the "Amioids" (the Pholidophoridæ having previously been classed with the "Lepidosteoids"), it has long been customary to recognise a break in the series of Teleostomatous fishes. All groups below have been united under the name of GANOIDEI (enamel-scaled fishes); all above have been termed TELEOSTEI (bony

fishes). This arrangement was very convenient so long as the extinct families were more incompletely known; but fossils now show that it cannot be scientifically maintained, and the

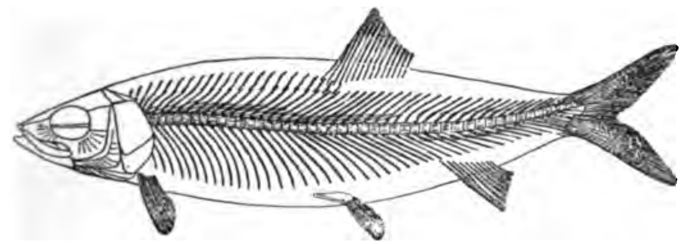


FIG. 102.—Restoration of *Leptolepis dubius*, scales omitted, from the Upper Jurassic Lithographic Stone of Bavaria; about one-third nat. size. (After A. S. Woodward. Table-case 23.)

terms "Ganoid" and "Teleostean" must accordingly be employed in future merely in a general way for enamel-scaled and modern bony fishes respectively.

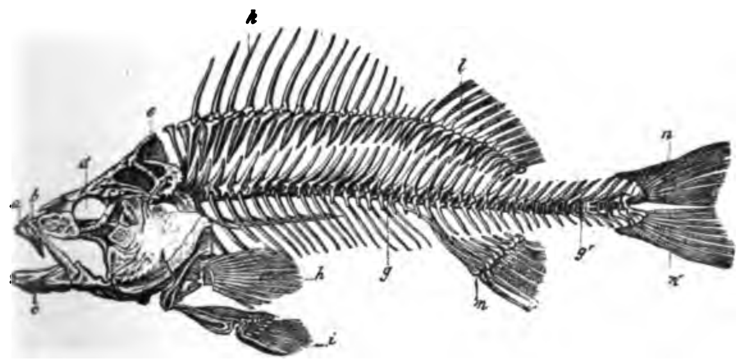


FIG. 103.—Skeleton of the Common Perch (*Perca fluviatilis*). *a.* premaxillary bone; *b.* maxillary bone; *c.* lower jaw; *d.* palatine arch; *e.* cranium; *f.* interoperculum; *g g'.* vertebral column; *h.* pectoral fin; *i.* pelvic fin; *k.* spinous dorsal fin; *l.* soft dorsal fin; *m.* anal fin; *n.* upper, and *n'.* lower lobe of caudal fin.

The pectoral and pelvic fins each form a pair, and correspond respectively with the anterior and posterior pairs of limbs of the higher vertebrata. The dorsal, caudal, and anal fins are median, unpaired, and peculiar to fishes.

Most of the so-called "Teleostean" fishes have a remarkably developed internal skeleton, as may be perceived from the accompanying figure of that of the common perch (Fig. 103). Very few are covered with bony scales, the large

majority being invested with thin and flexible deeply-overlapping scales, which are either smooth ("cycloid," Fig. 104, A) or pectinated ("ctenoid," Fig. 104, B) at the hinder margin.

A B

FIG. 104.—Scales of Teleostean Fishes. (A) Cycloid; (B) Ctenoid. The right border is exposed in the fish, and the grooved left border is deeply overlapped by the next scales.

Wall-case 15. Table-case 25.

Next to the Leptolepidæ in the collection are arranged the Elopidæ, which are the Cretaceous and Tertiary fishes perhaps most nearly related to the highest Jurassic families. Among these, in Table-case 25, the specimens of *Osmeroides* from the English Chalk are especially noteworthy, several having been beautifully worked out of the matrix by the late Dr. Mantell. Like many fossil fishes from the Chalk, they are almost uncompressed, the fine chalky mud having replaced the soft parts as rapidly as they decayed, thus preventing the collapse of the flanks and preserving almost the natural form of the living animal. *Thrissopater*, *Rhacolepis* and *Pachyrhizodus* are allied Cretaceous genera, while *Elops* and *Megalops* are Tertiary and still survive.

Wall-case 15. Table-case 25.

Among the Albulidæ may be noticed well-preserved skeletons of *Istieus* from the Upper Cretaceous of Westphalia (Wall-case 15), which can scarcely be distinguished from the existing deep-sea fish, *Bathythrissa*. In fact, many of the Westphalian Cretaceous fishes are related to living deep-sea genera, the eel-shaped Halosauridæ (*Echidnocephalus*) in Table-case 27 being especially remarkable.

Wall-case 16. Table-case 26.

The Chirocentridæ, which are proved by their sole survivor to be closely related to the "ganoids," are also well represented among Cretaceous fossils. The extinct forms are provided with powerful teeth implanted in distinct sockets on the margin of the jaw. *Portheus* attains a large size, as shown by a fine slab of *Portheus molossus* from the Kansas Chalk in Wall-case 16. More fragmentary remains of this genus, *Saurodon*, and *Ichthyodectes* are also exhibited from the English Chalk and Gault.

Table-case 26.

The Cretaceous Ctenothrissidæ are herring-like fishes which mimic the Berycoids in the anterior situation of the

pelvic fins and the serration of their scales. The Clupeidæ, or herrings-proper, date back to the same period and are represented both in Mount Lebanon and Brazil by *Diplomystus* (Fig. 105), which is also common in the European and North American Lower Tertiaries, and still survives in the rivers of

Table-case 26.

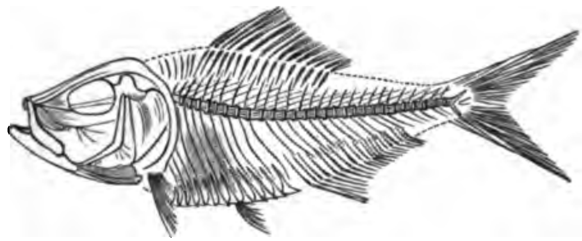


FIG. 105.—Restoration of *Diplomystus brevissimus*, from the Upper Cretaceous of Hakel, Mount Lebanon; somewhat reduced. (After Pictet and Humbert. Table-case 26.)

Chili and New South Wales. *Clupea* itself ranges upwards from the Eocene.

It is interesting to notice that in the Cretaceous seas the herrings and similar fishes already lived in dense shoals, which were sometimes suddenly destroyed. Slabs of hard limestone from Hakel, Mount Lebanon, exhibited in Wall-case 15, are covered with their remains.

Wall-case 15.

The Salmonidæ are scarcely known among fossils. Re-

Table-case 26.

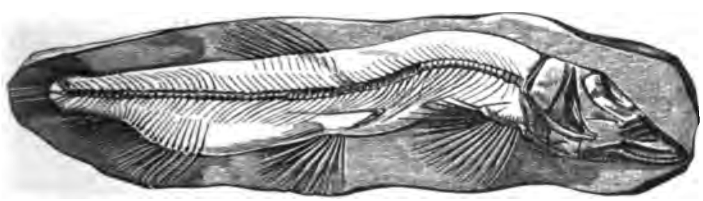


FIG. 106.—Capelin (*Mallotus villosus*) in nodule of Glacial Clay from Greenland; somewhat reduced. (Table-case 26.)

mains of some existing species are found in comparatively modern deposits, and an interesting series of nodules is exhibited from the glacial clays of Greenland, Norway, and Canada, each enveloping a "Capelin" (*Mallotus villosus*). The shape of the nodule (Fig. 106) is observed in every case to correspond precisely with the contour of the enclosed fish; and the concretion is probably due to the escape of gases

Table-case 27. from the decomposing body leading to a concentration of mineral matter from the surrounding clay.

The Dercetidæ are eel-shaped Cretaceous fishes, probably related to the deep-sea Halosauridæ, but with longitudinal rows of scutes or prickles in the skin. One specimen of

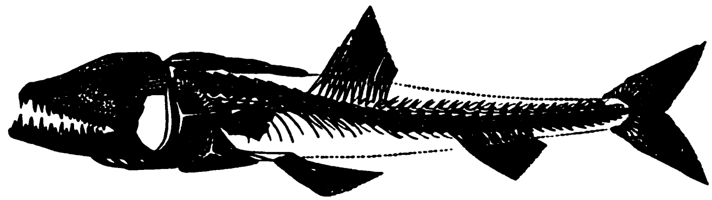


FIG. 107.—Restoration of *Eurypholis boissieri*, from the Upper Cretaceous of Hakel, Mount Lebanon; one-half nat. size. (After Pictet and Humbert. Table-case 27.)

Leptotrachelus, from the Upper Cretaceous of Mount Lebanon, in Table-case 27, shows a large fish in its interior, evidently swallowed, and proving the possession of a distensible stomach.

Wall-case 16. Table-case 27. The Enchodontidæ of the Cretaceous period are also closely allied to modern deep-sea fishes, but to the Scopeloid

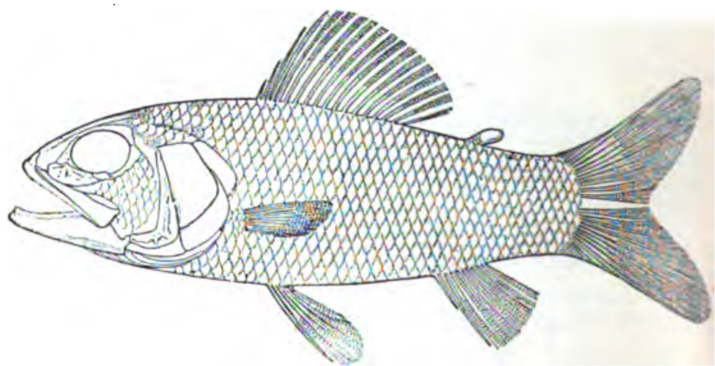


FIG. 108.—Restoration of *Sardinioides crassicaudus*, from the Upper Cretaceous of Westphalia; about one-third nat. size. (After A. S. Woodward. Table-case 28.)

group. They are remarkable for their very powerful teeth. The best-preserved skeletons are those of ***Eurypholis*** (Fig. 107) and *Enchodus*, from the Upper Cretaceous of Mount

Lebanon; but there are, in addition, numerous skulls, jaws, and other remains of *Enchodus*, *Halec*, and *Cimolichthys*, from the English Chalk. True Scopelidæ, such as *Sardinioides* (Fig. 108), are well preserved in the Upper Cretaceous both of Mount Lebanon and Westphalia. Probably related to these families also are the flying fishes named *Chirothrix*, from the Lebanon Chalk. **Table-cases 27, 28.**

The pikes, or Esocidæ, and the closely-related "toothed carps," or Cyprinodontidæ, are fresh-water fishes, of which very few ancestors are known. Good skeletons of *Esox* itself are exhibited from the Upper Miocene of Oeningen, Baden. Fossilised shoals of the small *Cyprinodon* are shown in fresh-water marl from the Lower Oligocene of Aix in Provence. **Wall-case 16. Table-case 28.**

SUB-ORDER 5.—**Ostariophysi.**

The past history of all fresh-water fishes is very imperfectly understood. Fresh-water deposits are of such limited extent that they rarely escape destruction for long geological periods; and, except perhaps for a few sediments deposited at the mouths of rivers, geology has as yet revealed little concerning the fresh-water life of Jurassic and Cretaceous times. Of the Characinidæ and Cyprinidæ (carps, &c.), therefore, very little is known among fossils, although they date back to the early Tertiary. The best examples are tench, roach, &c., from the Upper Miocene of Oeningen in Table-case 29. It is equally difficult to discover satisfactory fossil remains of the Siluroids, or "cat-fishes," although some of these are marine. The skull of *Bucklandium diluvii*, from the Lower Eocene London Clay of Sheppey, is typically Siluroid; and fragments from the Bracklesham Beds cannot be distinguished from the corresponding parts of the living genus *Arius*. **Wall-case 16. Table-case 29.** **Table-case 29.**

SUB-ORDER 6.—**Apodes.**

Typical eels have existed since the Cretaceous period, and *Urenchelys*, represented in Table-case 29 by fine specimens from the Upper Cretaceous of Mount Lebanon, only differs from the modern genera in possessing a distinct tail-fin. Well-preserved eels are also found in the Upper Eocene of Monte Bolca, near Verona (*Eomyrus*), and in the Upper Miocene of Oeningen, Baden (*Anguilla*). **Table-case 29.**

SUB-ORDER 7.—**Anacanthini.**

Wall-case 17. Table-case 30.

Cod-fishes are discovered first in the Oligocene black slates of Glarus, Switzerland, which were probably deposited in comparatively deep sea. The fossils belong to an extinct genus, *Nemopteryx*, and are exhibited in Wall-case 17.

Typical flat-fishes, resembling small turbots (*Rhombus*), are exhibited from the Upper Eocene of Monte Bolca; and there are soles (*Solea kirchbergana*) from the fresh-water Lower Miocene of Würtemberg.

SUB-ORDER 8.—**Percesoces.**

Table-case 30.

Although these are intermediate between the old bony fishes and the highest spiny-finned fishes, nothing is known with certainty concerning extinct members of the sub-order below the Upper Eocene. Good specimens of *Atherina*, *Mugil*, and *Sphyræna*, are exhibited from the Upper Eocene of Monte Bolca, and from the Lower Oligocene of Aix in Provence.

SUB-ORDER 9.—**Hemibranchii.**

Table-case 30.

The "pipe-fishes," "sea-horses," and their allies date back to the Upper Eocene, and several fine examples are shown in Table-case 30. *Calamostoma* is a "sea-horse" with a well-developed tail-fin, from the Upper Eocene of Monte Bolca.

SUB-ORDER 10.—**Acanthopterygii.**

Wall-cases 16–18. Table-cases 30–32.

The highest bony fishes with spiny fins first appear in the Upper Cretaceous, and nearly all the principal groups are represented among Eocene fossils. It is remarkable that they have undergone scarcely any change during the Tertiary period. Even so curious a fish as *Mene* (Fig. 111) is represented by typical skeletons in the Upper Eocene of Monte Bolca (Wall-case 17, Table-case 31).

Wall-case 16. Table-case 30.

As might be expected, most of the Cretaceous Acanthopterygii belong to the comparatively primitive family Berycidæ. The wonderfully well preserved specimens of *Hoplopteryx* (Fig. 109) from the English Chalk are especially noteworthy. *Homonotus* is another genus from the English Chalk, while *Acrogaster*, *Pycnosterinx*, and *Dinopteryx* are

from the Upper Cretaceous of Mount Lebanon. The living surface-dwelling genera *Myripristis* and *Holocentrum* are **Wall-case 16. Table-case 30.**

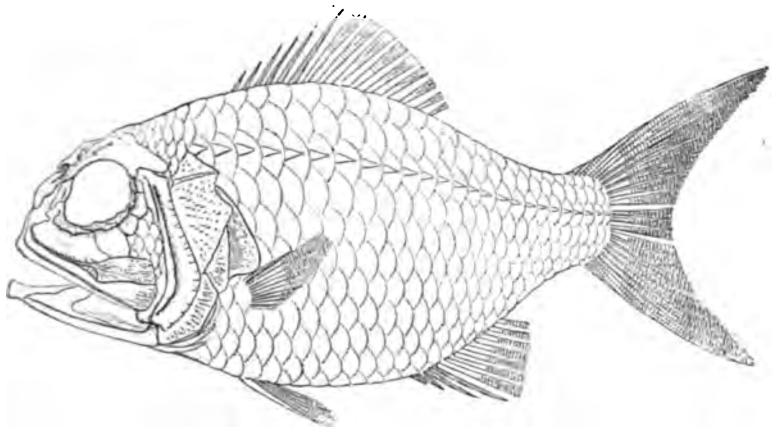


Fig. 109.—Restoration of *Hoplopteryx lewesiensis*, from the English Chalk; about one-third nat. size. (After A. S. Woodward. Wall-case 16, Table-case 30.)

Fig. 110.—Restoration of *Aipichthys minor*, from the Upper Cretaceous of Hakel, Mount Lebanon; nat. size. (After Pictet and Humbert. Table-case 31.)

Wall-case 16. Table-case 30. represented by skeletons from the Upper Eocene of Monte Bolca.

Fishes related to the Stromateidæ (*Platycormus*, *Berycopsis*) and Carangidæ (*Aipichthys*, Fig. 110) also occur in the Cretaceous of England, Westphalia, Austria, and Mount Lebanon; and an apparently true Percoid is known from the uppermost Chalk of France (*Prolates*).

Wall-cases 17, 18. Table-cases 31, 32. The Tertiary Acanthopterygii, which occupy Table-cases 31, 32, and Wall-cases 17, 18, are mostly referable to existing genera. Among fossil Carangoids *Mene* (Fig. 111),

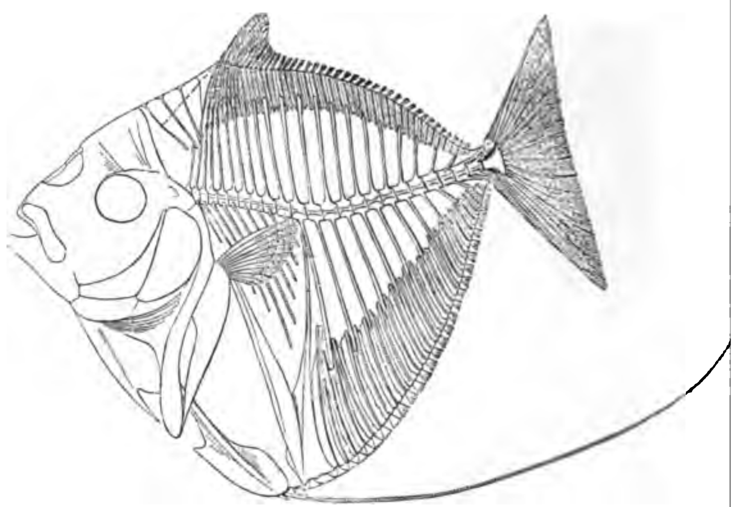


Fig. 111.—*Mene rhombeus*, from the Upper Eocene of Monte Bolca, near Verona; about one-third nat. size. (Table-case 31.)

Vomeropsis and *Semiophorus* (Fig. 112) from Monte Bolca are remarkable. Some of the jaws of the Scombroid *Cybium* from the English Eocene represent unusually large species. The long-bodied slender-snouted Palæorhynchidæ, chiefly from the Oligocene black slates of Glarus, are a strange early Tertiary family; as also are the Blochiidæ from the Upper Eocene of Monte Bolca. *Smerdis* (Fig. 113) is one of the commonest extinct Percoids, from the European Eocene. Oligocene, and Miocene. Sparidæ must have been very common throughout the Tertiary period, but they are usually represented merely by detached teeth (provisionally referred to *Chrysophrys*, etc.). There are, however, many good

FIG. 112.—*Semiophorus velicans*, from the Upper Eocene of Monte Bolca, near Verona; about one-third nat. size. *A*. anal fin; *C*. caudal fin; *D*. dorsal fin; *P*. below pectoral fins; *V*. pelvic fins. (Table-case 31.)

FIG. 113.—*Smerdis minutus*, from the Oligocene of Aix in Provence; nat. size. (Table-case 31.)

Wall-case 18. Table-case 32. skeletons of the extinct *Sparnodus* (Fig. 114), from Monte Bolca. There are also numerous throat-teeth of Labridæ, or "wrasses," and among these fossils the Eocene *Phyllodus*

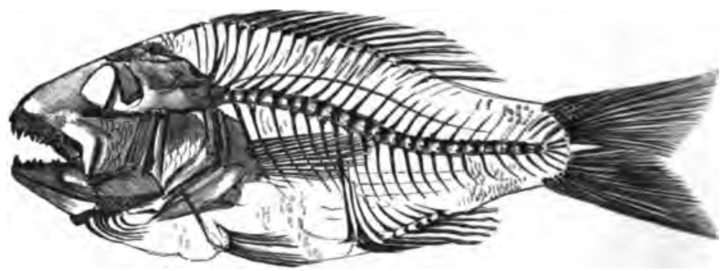


Fig. 114.—*Sparnodus ovalis*, from the Upper Eocene of Monte Bolca, near Verona; about one-third nat. size. (Table-case 32.)

Table-case 32. (Fig. 115), very common in the London Clay of Sheppey, is especially remarkable. Even the Scleroderms and Gymnodonts date back to the Lower Tertiary. Numerous teeth

Fig. 115.—Upper pharyngeal teeth of *Phyllodus polyodus*, from the London Clay of Sheppey; nat. size. (Table-case 32.)

Fig. 116.—Teeth of *Diodon scilla*, inner view, from the Miocene of Malta; nat. size. (Table-case 32.)

of *Diodon* (Fig. 116) are exhibited; and there are nearly complete skeletons of the same fish from Monte Bolca and from Oran, Algeria. *Acanthoderma* and *Acanthopleurus* are Scleroderms from the Oligocene of Glarus.

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GUIDE

TO THE

GALLERY OF FISHES

IN THE

DEPARTMENT OF ZOOLOGY

OF THE

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

ILLUSTRATED BY 96 FIGURES.

LONDON:
PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM.
1908.

ALERE FLAMMAM

PRINTED BY TAYLOR AND FRANCIS.
RED LION COURT, FLEET STREET.

PREFACE.

The arrangement of the Fish Gallery and the preparation of the coloured skins and casts which are there displayed, have occupied a good deal of my time for the last four years. The work of mounting and labelling have been done under my supervision by Dr. Ridewood; the preparation of coloured skins and casts by the taxidermists and modellers employed for the purpose.

If large series of fishes are to be exhibited to the public, it seems to be necessary that they should be carefully painted over so as to give, as far as possible, the natural colours of fresh specimens. This is an extremely difficult task and I have no doubt that, in spite of the care which has been taken, correction and revision will be needful hereafter, in regard to some of the specimens. Many of the specimens have been coloured from life and the rest from authoritative coloured drawings either published or communicated for the purpose.

The models of Deep-sea Fishes and of several extinct fishes have been most carefully executed under my constant supervision and are entirely new. The series of the species of living Dipneusta (*Prtoopterus* and *Lepidosiren*) are admirable representations of those fishes. The specimens of the Tunny, of the Flying Gurnards, and of the brilliantly

coloured Plectognaths, Angel-fish, and similar forms seem to justify the method of coloration employed. The principle had already been accepted by the late Keeper of Zoology, Dr. Günther, who had prepared several specimens coloured in this way. I believe that there is no other collection of Fishes in a public museum in which the specimens are presented without the usual iron supports, with sufficient space around each fish and in natural colours, instead of the oily brown which all dried fish skins tend to acquire.

The attitude of the specimens in the Gallery is *either* that of a dead specimen lying on a slab, *or* is a conventional one chosen so as to shew as much of the character of the fins as possible. It would not be possible to faithfully present the fish in the act of swimming, nor would fish in their natural surroundings be a desirable kind of exhibit: for, like many other animals, fish in their native haunts are usually concealed by their colour and surroundings from the observer's eye.

The present Guide has been prepared by Dr. Ridewood in daily consultation with me. Several of the illustrations are new: for others we are indebted to Guides formerly published by the Trustees, and to Messrs. Macmillan and Messrs. A. and C. Black.

Every specimen in the Gallery is provided with a number and is referred to in this Guide by that number printed in thick large type.

The English names or common names of specially interesting fishes are affixed in large letters to the glass of the case in a position near the specimens of such fishes.

All those fishes which come under the head of British Food-fishes are indicated in the case by the letters B. F. F.

The label of each specimen gives its zoological name, its local name, its English name or names, and as far as practicable its French, German and Italian names. The distribution of

the species is stated and the particular locality from which the specimen exhibited was obtained. In addition information is given as to any matters of special interest concerning the fish. This Guide is a collection of the labels with some additions, arranged systematically so as to shew the groups into which fishes are divided, and is illustrated by figures which are to a large extent taken from photographs of the specimens actually seen in the cases.

E. RAY LANKESTER,
Director.

British Museum (Natural History),
London, S.W.

Dec. 23, 1907.

ADDENDUM.

Since the above preface was written, it has been thought desirable not to use the "thick large type" for the numerals denoting the individual specimens, and these have therefore been printed in ordinary type.

collection of skeletons of Fishes is similarly available for purposes of scientific study.

On entering the Fish Gallery from the Bird Gallery the visitor will see two small Table-cases (21 and 22) standing in the middle line of the Gallery, the first containing specimens and enlarged models of the Lancelet, and the second containing Lampreys and Hag-fishes. These are not "Fishes" in the strict use of the word. The Lancelet is not even a vertebrate animal, in the sense in which that term is now employed, but belongs to the Cephalochorda, a division of the Chordata ranking equal with the Urochorda or Tunicates (Sea-squirts, Salps, &c., exhibited in the Shell Gallery), and the Vertebrata (including Lampreys, Fishes, Amphibians, Reptiles, Birds and Mammals). The Lancelet resembles the Tunicates and the Vertebrates in having a median skeletal rod, known as the notochord, in the dorsal position and tubular character of the central nervous system, and in the perforation of the side wall of the body in the neck region by gill-slits. The Lancelet differs from the Tunicates and Vertebrates in that the notochord extends farther forward than the central nervous system.

CEPHALOCHORDA (Lancelet).

Table-case 21.

The Lancelet or Amphioxus (fig. 1) is a small, semitransparent, marine animal about two inches in length (see specimens in alcohol, 1046, Table-case 21); it lives in shallow seas in many parts of the world and frequently buries itself in the sand. The edge of the mouth is produced into a number of curved bars or "buccal cirri" (see enlarged model, 1047), which act as strainers and prevent sand grains from getting into the mouth, while not stopping the water that is used for respiratory purposes, nor the minute living organisms that constitute the food of the Lancelet. The gill-slits do not open directly on to the exterior of the body, but are covered in by a wall called the atrial wall, which extends as far back as the pore (atriopore), through which issues the water that has passed through the gill-slits. The anus or vent is unsymmetrical, being set on the left side of the lower fin; there is no distinct head, no paired fins, and no paired eyes or ears.

For the general internal structure of the Lancelet the visitor is referred to the special case affixed to the side of one of the arches on the West side of the Entrance Hall of the Museum.

The two specimens A and B, 1048, mounted on the framed pane of glass in Table-case 21 are wax models, enlarged 100 diameters, showing the remarkable lack of symmetry that exists during the early or larval stages of the Lancelet. The mouth developes on the left side, and only subsequently passes downward to occupy a median position. Primary gill-slits, to the number of fourteen, appear in the ventral median line and move upwards on the right side. Eight secondary gill-slits then appear above them on the right side, and, as they enlarge, the primary gill-slits descend and pass across to occupy their permanent position on the left side. After this, tertiary gill-slits develope on both sides behind the existing ones and continue to increase in number throughout life. The

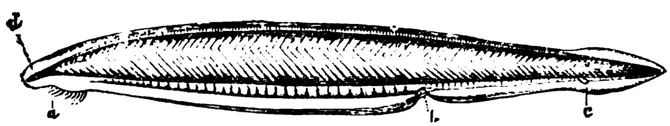

FIG. 1.—Lancelet: *a*, mouth; *b*, atriopore; *c*, vent or anus; *d*, anterior end of notochord.

three models 1049 C, D, and E on the other framed glass show the manner in which the atrial wall, which in the adult covers over the gills, closes by the downward and horizontal extension of the side folds of the body (metapleural folds), and the union of the edges of these flaps along the middle. The models represent three different stages of development, and show the ventral or under surface of the larva. In C there is no atrial floor, the right and left metapleural folds being distinct; in D the horizontal ledges growing in from the inner faces of the metapleural folds have united in the hinder part; in E the whole of the atrial floor is complete except at the extreme anterior end.

On the other side of the Table-case are shown enlarged models of Tunicates for comparison with the Lancelet, one (1050) of the larva of a simple Ascidian such as the common Sea-squirt, and three models (1051, 1052, 1053) showing different views of an

adult Appendicularia (*Fritillaria furcata*), which is one of the few Tunicates that retain the tail in adult life.

At the end of the case are shown drawings of ten species of the Lancelet.

CYCLOSTOMI (Lampreys and Hag-fishes).

Table-case 22. The Cyclostomi, or Lampreys and Hag-fishes, are aquatic Vertebrates not included among the "Fishes" or Pisces because of the absence of a hinged lower jaw. The mouth is adapted for sucking; when open it is round in shape (whence the name Cyclostomi, or "round-mouth"), and it is closed by the approximation of the right and left margins; the teeth are of a horny material and have a vertical succession. The body is long, without scales in the skin; the tail-fin is simple, and there are no paired fins and no traces of pectoral and pelvic girdles. The nostril is single; the gills are in pouches, the external and internal openings of which are small. The skeleton is fibro-cartilaginous, and the notochord persists for life. Two divisions of the Cyclostomi are recognised, the Hyperoartia (Lampreys) and the Hyperotreta (Hag-fishes).

In the Hyperoartia the external nasal aperture is on the upper surface of the head, and from the inner end of the nasal sac there leads back a tube which ends blindly above the pharynx (see dissection 1059). There are no barbels. The eggs are small (see 1060). Each gill-pouch has its own external aperture. The median fins are relatively larger, and are more subdivided than in the Hyperotreta. Various species of the Lamprey occur in the temperate parts of the northern hemisphere, the commonest being the Lamprey, *Petromyzon marinus*, 1057, and the Lampern or River Lamprey, *Petromyzon fluviatilis*, 1058.

Lamprey. The word Lamprey comes to us from the Low Latin name *lampreda* or *lampetra*, the licker or sucker of rocks, applied to the animal on account of its peculiar habit of adhering by its mouth to stones. The generic name *Petromyzon* applied by scientists refers also to this habit. The mouth when open (1062) forms a sucking disc, with numerous brown, horny teeth arranged in circular and radiating rows, and with some in the centre

supported by the tongue. The circular lip around this sucking disc is fringed with numerous short tentacles. The Lamprey does not "bite" its food as an animal with ordinary jaws would do, but attaches itself by its disc to the skin of living Cod, Haddock, and Mackerel, and gnaws away the flesh by its pointed conical teeth, until it has satisfied its hunger, when it leaves the fish to recover, or more probably to die.

The Lamprey has two dorsal fins, the second being continuous with the caudal; the skin is slimy, the eyes are very small and situated in front of the seven small, circular gill-openings. The skull of the Lamprey affords but little protection to the upper part of the brain, the roof consisting merely of a narrow "occipital arch" (see 1061). The "subocular arch" possibly corresponds with the palato-quadrate cartilage of the true Fishes, the cartilage which in Sharks and Lung-fishes functions as the upper jaw and bears the upper teeth.

Lampreys ascend the rivers from the sea in the spring to deposit their spawn. They grow to 30 inches in length and 3 lbs. in weight. They were esteemed a delicacy in olden times, but they are not much eaten at the present day; they are, nevertheless, wholesome food, and the historical incident firmly fixed in the memory of most schoolboys, that Henry I. died after a surfeit of Lampreys, should not be allowed to tell against them as an article of diet. In England the principal Lamprey fishery is in the Severn.

The Lampern, *Petromyzon fluviatilis*, 1058, bears a general resemblance to the Lamprey, but it rarely attains a greater length than 16 inches, at all events in British rivers. It usually spends the whole of its life in fresh water, although some individuals have been caught in the sea. Its skin is not mottled as is that of the Lamprey, and the eye is relatively larger. The Lampern does not seem to prey upon living fish as does the Lamprey. It makes excellent bait for Cod and Turbot. **Lampern.**

Planer's Lamprey, *Petromyzon planeri*, is smaller than the Lampern, and differs slightly in the arrangement of the teeth, the shape of the dorsal fin, and in its habit of living in the mud, whence it is sometimes called the Mud-Lamprey. The larval forms of the Lampern and Planer's Lamprey are known as

"Ammocœte" (1063), or more popularly as Pride or Sand-piper. The Ammocœte differs from the adult in having no tongue or teeth, in possessing a hood-like anterior lip instead of an oral sucker, in the large size of the internal or pharyngeal apertures of the gill-pouches, and in the fact that the respiratory part of the pharynx is not shut off by a horizontal partition from the food channel.

In South America and Australia the Lampreys are represented by the genera *Mordacia* and *Geotria* (1064).

In the Hyperotreta the external nasal aperture is situated at the extremity of the snout, and from the inner end of the nasal sac there leads back a tube which opens into the roof of the pharynx (see dissection 1066). There are barbels on the snout. The skin is capable of secreting enormous quantities of glutinous slime. The eggs are large (see 1068). In *Bdellostoma* (1067) each gill-pouch has its own aperture on the side of the body, but in the Hag-fish, *Myxine*, 1065, exhalent tubes from the pouches lead back and open together. *Bdellostoma* occurs plentifully in the bays along the Pacific coast of America; *Myxine* is found widely distributed in the temperate zones of the northern and southern hemispheres. Both feed on fish, and *Myxine* not infrequently bores its way into the abdominal cavity of the Cod.

Hag-fish.

PISCES (Fishes).

The Lancelet and Lampreys having been disposed of, there remain for consideration the true Fishes or Pisces, a class of the Vertebrata ranking equal with the Amphibia (Frogs and Newts), Reptilia (Turtles, Crocodiles, Lizards, Snakes), Aves (Birds), and Mammalia (Mammals, *e.g.* Rabbit, Dog, Horse, Man).

Fishes are Vertebrate animals with a distinct and hinged lower jaw, passing their whole life in water (with a few exceptions), and possessing common distinctive characters in those systems of their organization which are in direct relation to their aquatic mode of life, namely, in the organs of respiration and locomotion. The respiratory organs are gills, groups of delicate vascular filaments

projecting from the front and hind walls of the gill-slits, and supported by skeletal bars called branchial arches. An air-bladder is frequently present and serves as a hydrostatic organ or float, while in a few cases it may act as a lung and help the gills in their work of respiration. The organs of smell are paired, and only in rare cases (Lung-fishes) communicate with the mouth-cavity by internal nostrils. Except in the Lung-fishes the heart has but one auricle and receives only venous blood, which it forces, first through the blood-vessels of the gills and thence as arterial blood through the vessels of the body generally. The skin is either soft and bare or is hardened by the development of spines or denticles, or overlapping scales, or bony plates (scutes). Peculiar cutaneous sense-organs are distributed along the sides of the body (lateral line organs) and on the head, and appear to be specially associated with an aquatic mode of life. Such organs only occur elsewhere in Amphibians; in the tailless Amphibians (Frogs and Toads) they exist only in the larval or tadpole stages (except in the Cape-toad, *Xenopus*). The principal organ of locomotion is the powerful muscular tail; this is assisted by the pectoral and pelvic limbs, paired fins corresponding with the fore and hind limbs of terrestrial Vertebrates. The skeleton of these paired fins cannot readily be compared with the limb-skeleton of other Vertebrates, there being no such bones as humerus, radius, carpal and phalangeal bones, and the edge of the fin is not divided into the five toes, which are, with exceptions, so regularly present in all other Vertebrates. Fishes also possess median fins on the back (dorsal fins) and between the anus and tail (anal fin); these fins are supported by skeletal bars or rays, whereas in Newts and other Vertebrates with median fins there are no skeletal structures in those fins.

The scheme of classification adopted in the arrangement of the Fish Gallery is set out on pages 200–201. The systematic series of Fishes is exhibited in the Wall-cases, commencing with Wall-case 1 (Sharks and Dog-fishes) in the S.W. corner of the Gallery, and ending with Wall-case 20 (Angler-fishes, File-fishes, Globe-fishes, and Sun-fishes) in the S.E. corner. Standing on the floor of the Gallery or suspended from the roof are other

specimens, either too large to exhibit in the Wall-cases, or else constituting series of special interest, such as Deep-sea Fishes, Eggs and Young of Fishes, &c.

Central Exhibits.

The Table-cases 21 and 22, containing specimens of the Lancelet and of Lampreys and Hag-fishes, encountered by the visitor on entering from the Bird Gallery, have already been alluded to (pp. 2–6). In the same line is a third Table-case (23) containing a Port Jackson Shark, *Cestracion philippi*, four feet long, caught in Sydney Harbour in 1906.

Basking Shark. In the middle of this half of the Gallery, surrounded by a mahogany rail, is the cast of a skeleton of the Basking Shark, *Selache maxima* or *Cetorhinus maximus*, which was caught off Bergen, in Norway, in May 1901, and measured 28½ feet. The

Fig. 2.—Basking Shark, *Selache maxima*.

principal features of the skeleton of Sharks may be studied by reference to this specimen. The great jaws are connected with the cranium by the upper piece of the hyoid arch called the hyomandibular cartilage—a skull in which the jaws are so suspended is called "hyostylic" (compare the "amphistylic" skull of *Notidanus* (Wall-case 1) and the "autostylic" skull of the Holocephali (Wall-case 5), and Dipnoi. The characters of the gill-arches and gill-rays are well shown in this specimen, as also

are the features of the vertebral column, the pectoral and pelvic girdles, and the skeletal parts of the pectoral, pelvic, dorsal, anal and caudal fins, except that the horny fin-rays are not reproduced in the cast. For an illustration of horny fin-rays the visitor is referred to the skeleton of the pectoral fin of the Dog-fish (3) in Wall-case 1.

Hanging from the roof above the skeleton is a specimen of the Basking Shark, 28 feet long, caught off Bergen in 1904, and presented to the Museum by the Hon. Walter Rothschild. The Basking Shark grows to 33 feet or more. Its food consists of small fishes and other marine animals that swim in shoals. The gill-rakers are highly specialised, and serve to retain the smallest food organisms and to prevent their escaping through the gill-slits. On the west coast of Ireland the Basking Shark is caught for the sake of the oil obtained from the liver. The Shark is of a harmless disposition and does not attack man.

On the left side of the skeleton is the head of a Basking Shark which was 28 feet long, and was caught in March 1875 near Shanklin, in the Isle of Wight*. This head shows the great size of the gill-slits, the right and left of which nearly meet under the throat, and the smallness of the teeth. On the other side of the skeleton are the pelvic fins of the same specimen, which was a male. The males of all Sharks have the pelvic fins produced backward into "claspers," and the interest of the present specimen lies in the fact that the tooth-like bodies on the claspers of the Basking Shark were first known in the fossil state, and their true nature was only recognised when the Shanklin specimen was exhibited in the year 1876. Three examples of fossil clasper-spines are exhibited in the box adjoining. These are from the Red Crag of Suffolk; similar specimens have been obtained from the Crag of Antwerp. Such spines were long a puzzle to palæontologists, by whom they were regarded as the terminal phalanges of some large Reptile or Mammal, or the separated lamellæ of young teeth of a Mastodon or Mammoth, or the central cores of teeth of a Xiphioid Whale.

* Figure 2 was drawn from this specimen.

Rays. On the floor within the same railing are specimens of an Electric Ray, *Torpedo hebetans*, 1080, caught in the Menai Straits, North Wales, and a large Ray, *Raia marginata*, 1079, caught in Walfish Bay, South-west Africa.

Hanging from the roof in the middle of the Gallery are two other large Rays, both from Muscat, in Arabia—an Eagle-Ray, *Aëtobatis narinari*, and a Devil-Ray, *Dicerobatis eregoodoo*, a fish which grows to 15 feet in width, and is distinguished by the paired projection (head-fins) in front of the mouth.

Beyond these Rays, also hanging from the roof, is a Whale Shark, *Rhinodon typicus*, the largest of all Sharks, growing to 50 or 60 feet in length; the specimen shown is not more than half the full size. The Whale Shark occurs mostly in the Indian and Pacific Oceans and has been caught off Florida and the Cape of Good Hope. Like the Basking Shark the Whale Shark is a slow-moving, apathetic fish, harmless to man, and often found basking or sleeping at the surface of the sea. The mouth and nasal openings are near the extremity of the broad, flat snout. The dorsal fin is much farther back than is that of the Basking Shark, and the gill-slits are not so large. The teeth are extremely small for so large an animal (see specimen 53 in Wall-case 1), and are closely set in regular rows in the form of a ribbon. The Whale Shark feeds on the minute semitransparent crustaceans and molluscs that abound at the surface of the sea, and to a certain extent also on sea-weed.

Hanging from the roof at the North end of the Gallery is a large specimen of the Sun-fish, *Orthagoriscus mola*, from Australia, and hanging near it is a smaller specimen of the same species caught off Dungeness in Kent (see fig. 3).

Side-rails. Running the whole length of the Gallery are two side-rails suspended from the roof by chains. Hanging from these rails are, besides the Sun-fish just mentioned, a Sturgeon * (opposite Wall-cases 6 and 7), 10 feet 4 inches long, caught off the Dogger

* For information concerning the structure and habits of these suspended fishes the visitor is referred to the accounts given in the description of the Systematic Series of Fishes exhibited in the Wall-cases.

Bank in 1873; a Saw-fish, *Pristis pectinatus* (in front of Wall-case 5) from Trinidad; a Greenland Shark, *Læmargus borealis* (in front of Wall-cases 3 and 4), 15 feet long, caught on the East coast of Scotland in 1878; a Thresher or Fox Shark, *Alopecias*

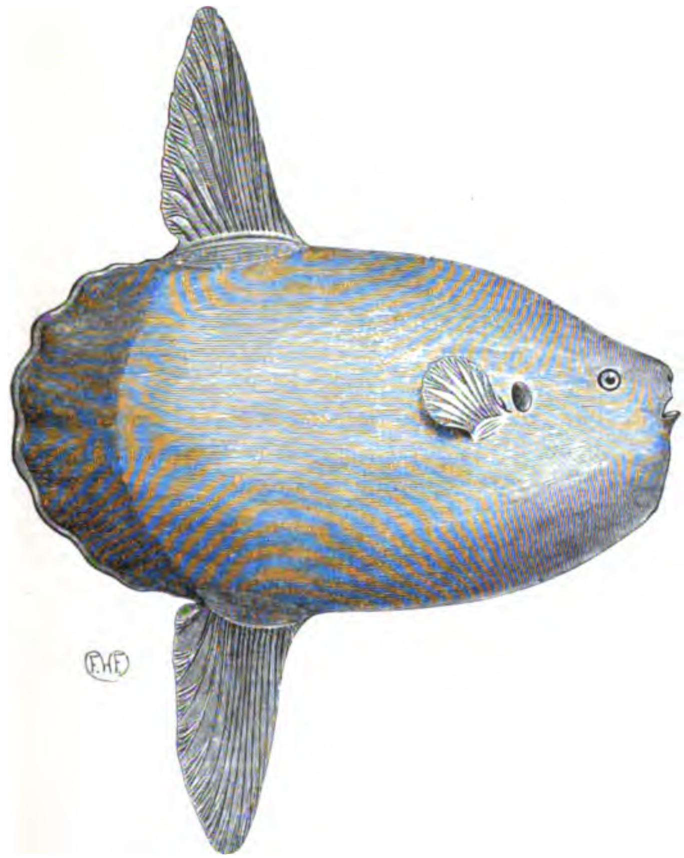

FIG. 3.—Rough Sunfish, *Orthagoriscus mola.*

vulpes (opposite Wall-case 3), caught on the Devon coast in 1897; a Shark of the Indian Ocean, *Ginglymostoma cirrhatum*; and a Grey Shark, *Notidanus griseus* (opposite Wall-case 1) from the Orkney Isles.

On the other rail are an *Odontaspis americanus* (opposite Wall-case 20); an Elfin Shark, *Mitsukurina owstoni*, caught in 300 fathoms off Japan in 1903; an Indian Shark, *Carcharias hemiodon*, allied to the Blue Shark and White Shark, which are also species of *Carcharias*; a stuffed specimen and a pair of jaws of a Shark known as *Galeocerdo rayneri*, the teeth of which are curiously marked by a deep notch on the outer edge; a stuffed specimen and a pair of jaws of the Hammer-head Shark, *Zygæna malleus*; and two Sting-Rays, *Trygon brevicaudata*, from New Zealand, and *Trygon tuberculata*, from Australia.

Floor-case 27. Near the doorway at the North end of the Gallery and occupying a middle position between Wall-cases 8 and 13, is a Floor-case (27), which, at the time of writing, contains a Tarpon, *Megalops atlanticus*, 1110, seven feet long, presented in 1899 by His Majesty the King, then Prince of Wales; also a large Angler, *Lophius piscatorius*, 1016, and an Opah, *Lampris luna*, 1108, both presented by the Hon. Walter Rothschild; also a skeleton of the Opah, 1109. Close around this Floor-case are five Cabinet-cases (26, 28, 29, 30, 31) the arrangement of which is not at the time of writing sufficiently complete for description. They are intended for series of eggs and young of Fishes, nests and modes of protection of the young, long-bodied eel-like fishes of different families, Electric Fishes, Flying Fishes, Sound-producing fishes, fishes with poisonous flesh, fishes with poison-spines, fishes with suckers, fishes with accessory breathing-organs, hybrids in fishes, differences between male and female fishes, isinglass from Sturgeon and *Polynemus*.

In the vicinity of the Cabinet-cases are three skeletons under glass, standing on separate tables, namely, the Nile Perch, *Lates niloticus* (Table-case 33), from the Fayûm Lake, Egypt, a skeleton 55 inches long; a Parrot-fish, *Pseudoscarus muricatus* (Table-case 32), with the pharyngeal bones separated from the rest of the skeleton to show the curious pavement of pharyngeal teeth; and a Stone Bass or Wreck-fish, *Polyprion cernium* (Table-case 34), of which a stuffed specimen is shown in the left upper part of Wall-case 13.

On the large table between Wall-cases 6 and 15, surrounded by a mahogany rail, are a Great Blue Shark, *Carcharodon rondeletii*, from the Atlantic coast of North America, and, on the other side, a Mackerel Shark, *Lamna spallanzanii*, and the jaws of a Mackerel Shark, and those of a Great Blue Shark much larger than the one shown on this table. On the floor within the railing are a number of specimens, the final positions for which have not at the time of writing been decided; they are a skeleton of the Southern Ribbon-fish, *Regalecus argenteus*, a very fine specimen, 12 feet long; a specimen of *Euoxymetopon poeyi*, a fish allied to the Hair-tails Wall-case 17); a skeleton of the deep-sea fish *Alepidosaurus ferox*, with great teeth and a large dorsal fin supported by unbranched fin-rays; a form of Sea-perch, *Epinephelus cernioides*, not very large considering to what a great size some of the Sea-perches or Jew-fishes attain, but interesting as being a specimen caught off the Cornish coast; a Meagre, *Sciæna aquila*; a Skate, *Raia batis*; a Sturgeon, *Acipenser sturio*; and a Quinnat Salmon, *Onchorhynchus quinnat*, which weighed 70 lbs. when caught.

Great Blue Shark. Table 25.

Standing between the two railed enclosures in the middle line of the Gallery is a Floor-case (24) devoted to the Sword-fishes and Sail-fishes. A description of the contents of this case is given on page 170.

On one side of the Sword-fish case (24) is a small Table-case (37) containing a skeleton of one of the African Siluroids or Cat-fishes, *Arius latiscutatus*, and on the other side a Table (49) with a large Halibut, *Hippoglossus vulgaris*, 6 feet 2 inches long, caught in the North Sea in 1902, and a cast of a very fine *Lepidotus maximus*, from the Lithographic Stone of Bavaria, an extinct fish of the family Semionotidæ (see Wall-case 7).

In front of Wall-cases 6 and 7 stand two Table-cases (50 and 51) with a skeleton and two specimens of the great *Arapaima gigas* of the Amazon and neighbouring rivers, a fish belonging to the family Osteoglossidæ (see Wall-case 7 and page 89). Opposite these cases, in front of Wall-cases 14 and 15, are two Table-cases (36 and 35) containing a large specimen of *Platystoma gigas*, from the Upper Amazons, and a skeleton of an equally large *Bagarius*

yarrellii from the Hugly; both of these are Cat-fishes or Siluroids (see family Siluridæ, Wall-cases 9 and 10, and page 112).

Tunny. On the other side of the door-way leading into the Entrance Hall is a large Table-case, 38, standing in front of Wall-case 17, containing a very fine specimen of the Tunny, *Thunnus thynnus* (fig. 4), 8 feet long, caught in the English Channel off Weymouth, and also an Albacore, *Thunnus alalonga*; these are Scombroid or

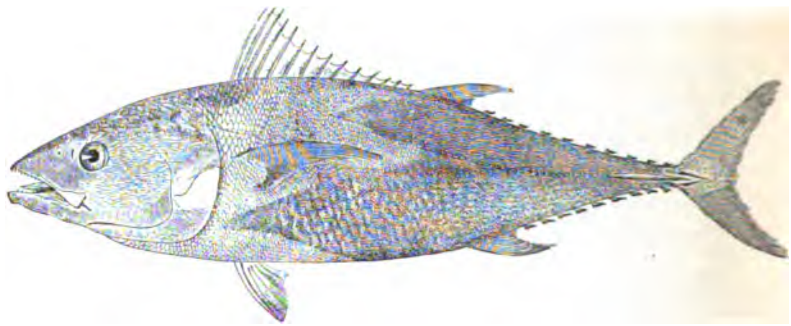

FIG. 4.—Tunny, *Thunnus thynnus*.
(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.).

Mackerel-like fishes (see Wall-case 15, and p. 165). Next follow four Table-cases (39, 40, 41, 42), with a Barracuda, *Sphyræna commersonii*, from Mauritius (see Wall-case 11 and p. 136); a large Sea-perch, *Epinephelus lanceolatus*, 7 feet 3 inches long, from the Indian Ocean (see family Serranidæ, Wall-case 13 and page 147); and a skeleton and a stuffed specimen of the Angler, *Lophius piscatorius* (family Lophiidæ, Wall-case 20, floor; see also page 193).

British Salmonoid Fishes. In Cabinet-case 43, standing in front of Wall-case 20, are shown some Salmonoid Fishes of the British Isles; at the time of writing the series is very incomplete. Other specimens of Salmonoid Fishes are shown in the series of British Fresh-water Fishes in the North Wall-case of the Pavilion at the West end of the Bird Gallery, and some in Wall-case 7 of this Gallery. The tendency of modern students of fishes is to diminish the number of species to which Salmonoid fishes are relegated, and to regard the colouring of the body as of little account compared with such characters as

the size of the scales, and the number of rows in which they are arranged, the positions of the fins and the number of fin-rays in each, the characters of the teeth and the proportions of the bones of the upper jaw and of the gill cover, these characters being reasonably stable, whereas the colouring is largely dependent on the conditions in which the fishes live. As a rule the fresh-water forms are brown or reddish, and the marine forms bright and silvery, and in the case of migratory forms like the Salmon and Sea Trout the change from the one colour to the other is to be observed in the same individual at different periods of its life. In the non-migratory forms the colours are fairly constant while the fish remains in the same waters, but by transferring to new localities brown forms may become silvery and silvery forms brown.

The relation that obtains between the environmental conditions and the colouring of the fish is expressed by Dr. Günther * in the following terms:—"Trout with intense ocellated spots are generally found in clear rapid rivers and in small open alpine pools; in the large lakes with pebbly bottom the fish are bright and silvery, and the ocellated spots are mixed with or replaced by X-shaped black spots; in pools or parts of lakes with muddy or peaty bottom the trout are of a darker colour generally; and when enclosed in caves or holes they may assume an almost uniform blackish coloration."

The remarkable differences in the colouring of Trout living in neighbouring, but non-communicating, waters is nowhere better exemplified than in Sutherland. Loch Scourie, Loch Crocach, Loch Borlane and Loch Manse all have their own particular type of Trout (see 995, 997, 996, 994). In deep lakes where food is fairly abundant the Trout grow to a large size, and such fish are called Great Lake Trout, fishes long known as *Salmo ferox*. The specimen of Great Lake Trout, 999, exhibited in the Cabinet-case, is from Windermere.

In Loch Leven the Trout, formerly described as *Salmo levenensis*, are slender and more silvery than most non-migratory Trout, with less yellow along the sides of the abdomen and with spots that are dark and without any scarlet. Examples of a male and a female are shown (991, 992). The Galway Trout, of which a specimen

* "An Introduction to the Study of Fishes," 1880, p. 632.

from Connemara is shown, 993, is the fish described by some authorities as *Salmo gallivensis*; it is a robust fish of estuarine habit. Another Irish Trout is 998, a fish from Lough Arrow in Sligo. The Sea Trout is represented by an $8\frac{1}{4}$ lb. fish caught in the sea at Montrose, a 7 lb. fish caught in the Tay at Perth, and a Smolt from the Tay, caught in May.

If the colouring of the body be disregarded, the British species of *Salmo* may be reduced to three, namely, *Salmo salar*, the Salmon and its varieties, *Salmo trutta*, including all the Trouts, such as Salmon Trout, Bull Trout, Great Lake Trout and Brook Trout, and *Salmo alpinus*, including all the Charrs. At the time of writing the Charr is represented in Cabinet-case 43 by three specimens, from Buttermere, Windermere and Loch Scourie respectively.

Deep-sea Fishes.

Deep-sea Fishes (see Cabinet-case 44) are not fishes of any particular order, but are fishes of genera belonging to numerous families more or less unrelated which have a deep-sea habit, the other members of the families being surface forms or coast forms. The proportions of the deep-sea genera to the others varies in different families. The families Alepocephalidæ (Wall-case 7), Stomiatidæ (Wall-case 7), Scopelidæ (Wall-case 10), Halosauridæ (Wall-case 10), Macruridæ (Wall-Case 11), Ceratiidæ (Wall-case 20) consist almost entirely of deep-sea forms, whereas among the Eels (Wall-case 8) and Gadidæ (Wall-case 11) a moderate proportion of the genera occur in deep water, and in the Salmonidæ only a very few, such as the Argentine (295, Wall-case 7).

While the animals that live in shallow seas near the coast—animals such as fishes, crustaceans, molluscs, worms and jelly-fishes—exhibit considerable differences in different parts of the world, this is not the case with the animals which inhabit the deeper parts of the sea. The species of deep-sea fishes and other animals which are at all well known have a wide distribution.

Removed from the glare of the sun, the fishes of the deep seas have become modified in relation with the subdued light in various directions. Most have exceptionally large eyes (e.g. *Aphanopus*, 982, Cabinet-case 44), so as to bring to a focus as much as possible of the faint light that succeeds in penetrating to the great depths; a few have eyes which have undergone so much reduction that the fishes are blind, and rely for the capture of their food upon the

increased acuteness of sense organs other than the eyes; some again are uniformly phosphorescent or have special luminous organs on the head or in series along the body.

Most are of a pale green or blue colour when caught (see coloured sketches 980 and 981), but they rapidly turn black; it is for this reason that the coloration of many of the models shown is blackish. Some deep-sea fishes are colourless and gelatinous in appearance (e. g. *Aphyonus*, 974). In those which are coloured the coloration is mostly uniform, without spots or bands, and without the belly being paler than the back and sides. A few are silvery (e. g. *Lepidopus*, 971).

Many fishes obtained from great depths come to the surface in a damaged condition owing to the expansion of the gases in the tissues of the body when relieved from the great pressure to which they are subjected at the bottom of the sea. For this reason few

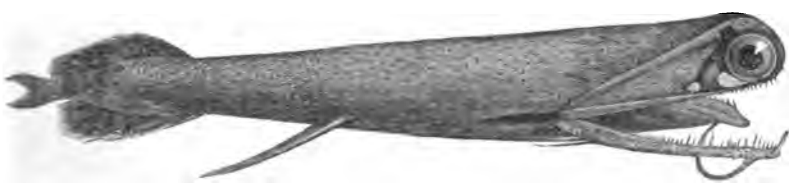

FIG. 5.—A Deep-sea Fish, *Malacosteus indicus*.
(From Boulenger, Camb. Nat. Hist. vii, 1904, after Günther.)

are suitable for exhibition, and most of the specimens shown in Cabinet-case 44 are models, some of them enlarged, made to present as nearly as possible the appearance that the fishes would offer in their natural state.

Most of the deep-sea fishes are known by a few specimens only, and, being rare, they have no popular names.

Aulostomatomorpha (984) is a curious fish in which almost the whole of the skin of the head is phosphorescent; in *Malacosteus* (979, and fig. 5) there are two photophores or luminous organs situated below and behind the large eye; in *Ipnops* (976) the eyes are wanting and the top of the broad, flat head is occupied by a pair of large photophores, which nearly touch one another in the middle line.

Gastrostomus (985, fig. 6 *a*) and *Saccopharynx* (986, fig. 6 *b*) are related to the Eels; they are predaceous fishes, with the eyes set

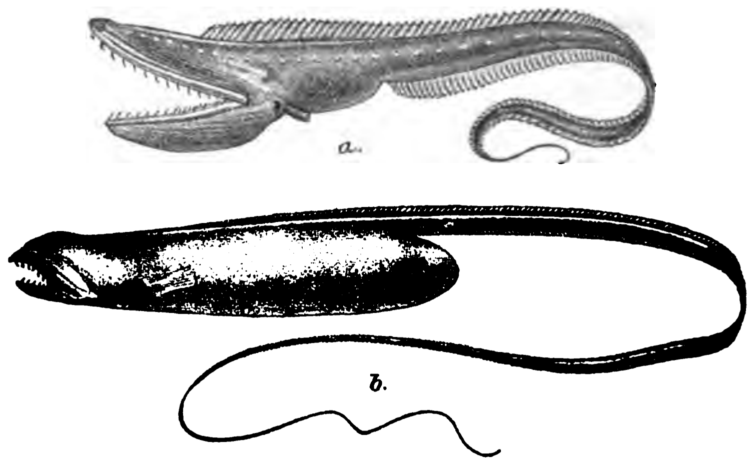

FIG. 6.—Two Deep-sea Fishes allied to the Eels: a, *Gastrostomus bairdi*, and b, *Saccopharynx flagellum*.

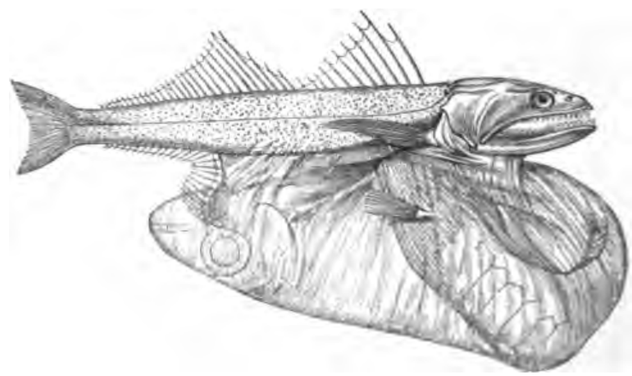

FIG. 7.—A Deep-sea Fish, *Chiasmodon nigrum*.
(From Günther, "Study of Fishes".)

very far forward, and with a long tail tapering off to a thread. The former fish is remarkable for the enormous size of the mouth. Both are provided with a highly distensible stomach and abdominal

wall, by virtue of which the shape of the fish is greatly changed after a good meal. In the case of *Saccopharynx* (986), for instance, the size of the abdomen is due to the fish having swallowed another fish of considerable size shortly before it was itself caught. A still more remarkable case is that of *Chiasmodon* (978, fig. 7), which prior to capture had devoured a fish larger than itself, and the shape of which was clearly discernible through the tightly stretched wall of the distended abdomen when the fish came to hand.

Chauliodus (975, and fig. 8) is a fairly common deep-sea fish, chiefly remarkable for the great length of its teeth. *Bathypterois* (983) is a small-eyed fish presenting a great elongation of the uppermost ray of the pectoral fin and the foremost two rays of the pelvic fin; these filamentous rays are doubtless used as "feelers." A similar function may be attributed to the rays of the paired fins of *Paraliparis* (973), a fish allied to the Sea-snails (*Liparis*, 836 and 837, Wall-case 19) of the English coast.

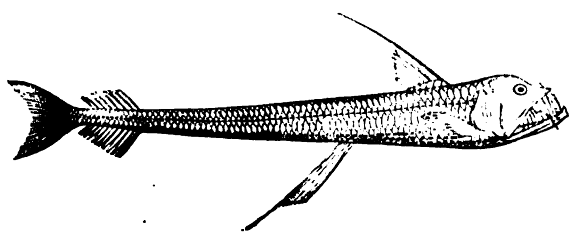

FIG. 8.—A Deep-sea Fish, *Chauliodus sloanii*.
(From Günther, "Study of Fishes.")

Dolopichthys (972) is a fish belonging to the Ceratiidæ, a deep-sea family related to the Angler-fishes. The "lure," which serves as a bait to induce the prey to come within reach of the jaws, and which is suspended from the end of a long fin-ray of the dorsal fin, is in *Dolopichthys* a luminous structure.

The fishes represented in Cabinet-case 44 are only the most striking and exceptional of the deep-sea fishes. Those less modified are shown in the systematic series in the Wall-cases.

Following Cabinet-case 44, in a series along the side of the Gallery, are four Table-cases (45–48) with a skeleton of the Porbeagle Shark, *Lamna cornubica* (see the specimen in the upper part of Wall-case 1, see also page 32); a Jew-fish, *Stereolepis gigas*, a Sea-perch allied to the large specimen in Table-case 40 in a corresponding position on the other side of the Gallery; a Southern Meagre, *Sciæna antarctica*, and a skeleton of the Common Meagre, *Sciæna aquila* (family Sciænidæ, Wall-case 13; see also page 151); and another form of Meagre, *Sciæna diacanthus*, from the estuaries of Bengal.

Systematic Series in the Wall-cases.

In Wall-case 1, in the S.W. corner of the Gallery are exhibited the more primitive of the Sharks and Dog-fishes; the series of Sharks and Dog-fishes is continued in Wall-case 2 and ends with the Monk-fish and *Pristiophorus*. In Wall-cases 3 and 4 are shown the Saw-fishes, Skates and Rays, and in the lower part of Wall-case 4 reference is made to the extinct Pleuracanthodian Sharks. Wall-case 5 is devoted to the Holocephali and Ostracodermi. The Dipnoi or Lung-fishes occupy the first part of Wall-case 6, the Stylopterygii or Fringe-finned fishes, and the Sturgeons and Gar-pikes fill up the rest of the case. In Wall-case 7 are the Amioid fishes and their extinct relatives, also the lower Teleostean fishes, the Herring-like and Salmon-like fishes. Wall-case 8 contains the Carps and their allies, and, on the floor, the Eels; the Cat-fishes occupy the corner case (9) and a part of Wall-case 10, the rest of which is filled by the Pikes, Sticklebacks, Sea-horses, Pipe-fishes, &c.

In Wall-case 11 are shown the Grey Mullets, Flying-fishes, and Barracudas, and the Cod-like fishes. In the corner case (12) begins the great series of fishes with spiny fin-rays in the dorsal, anal and pelvic fins (Acanthopterygian fishes), a series which continues along the whole of the East side of the Gallery up to Wall-case 19. The first fishes of the series are the Berycoid

fishes, in Wall-case 12, together with the Archer-fish and the Perch, and in Wall-case 13 there follow the Sea-perches, Basses and Meagres. The Snappers, Sea-Breams, Red Mullets and Chætodont fishes are shown in Wall-case 14, and the Surgeon-fishes, Parrot-fishes, Wrasses and Mackerel-like fishes in Wall-case 15.

The small Wall-case 16 is devoted to the Horse-Mackerels, and Wall-case 17 to the Frost-fishes and Dolphin-fishes. Wall-case 18 includes the Dorys, the Flat-fishes, such as the Sole, Plaice and Turbot, and the Sucking-fishes and Gobies. In the upper part of Wall-case 19 are exhibited life-sized coloured drawings of the Ribbon-fishes, and in other parts of the case are specimens of Gurnards, Lump-suckers and Blennies. The systematic series ends with Wall-case 20, which contains the Angler-fishes (on the floor), the File-fishes, Globe-fishes and Sun-fishes.

ELASMOBRANCHII (Sharks and Rays).

The Elasmobranchii, including the Sharks, Dog-fishes, Saw-fishes, Skates and Rays, are marine fishes with a skeleton composed of cartilage, the surface of which is usually calcified, but does not exhibit the characters of true bone. The skin possesses tooth-like structures called placoid spines, which when closely set constitute shagreen. The vertebral column is in most instances continued into the upper part of the tail fin, and the lower lobe is small as compared with the upper; such a tail is known as "heterocercal." The fins are supported by closely-set rods and plates of cartilage in the basal parts, and by horny fin-rays in the marginal parts (see specimen 3). There is no gill-cover, and, with a few exceptions, five gill-slits open on each side of the body. The heart has a chamber known as the *conus arteriosus*, which is provided with watch-pocket valves that prevent the return of blood to the ventricle (see dissection 2). The intestine has a spiral valve (see dissection 1) and there is no swim-bladder. The ova or egg-cells are large, and undergo their development either within the body of

Wall-case 1.

the mother or within horny egg-shells (see specimens 7, 4, 5, 6 and fig. 9). In the scheme of classification adopted in this Gallery

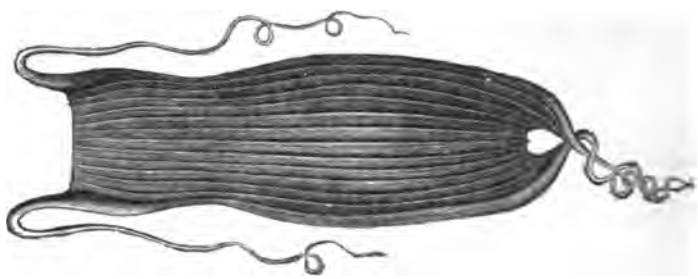

FIG. 9.—Egg of a Dog-fish of the genus *Scyllium*. (From Günther, "Study of Fishes.")

(see pp. 200–201) the Elasmobranchii are divided into four orders, Proselachii, Acanthodides, Selachii, and Pleuracanthodes.

PROSELACHII (Primeval Sharks).

The Proselachii or Pleuropterygii are extinct Sharks, the most primitive as well as the most ancient of the Elasmobranchii. The only genus of which the general structure is at all well known is *Cladoselache* (fig. 10), but detached teeth resembling those of *Cladoselache* have long been known in the Carboniferous formations under the name of *Cladodus* (see tooth of *Cladodus striatus*, 10). The gill-slits are five or more in number; the upper and lower jaws are approximately equal in size and are suspended from the cranium by the hyomandibular cartilage. The dorsal and the paired fins are supported by parallel fin-rays of calcified cartilage which extend nearly to the margin of the fin. Dermal fin-rays have been described in the posterior edge of the fin, but the evidence of their presence is unsatisfactory (see pectoral fin, 8). The length of these Sharks varies between two and six feet.

Cladoselache.

The remains of *Cladoselache fyleri*, found in the Cleveland Shale (Upper Devonian or Lower Carboniferous) of Ohio, are sufficient to show that the form of the body was rounded and

elongated (see fig. 10, and the enlarged drawing 9 at the top of Wall-case 1). Two dorsal fins are present, but no anal fin. The caudal portion of the vertebral axis is strongly upturned, and distinctly hinged upon the rest of the vertebral column, but the outline of the tail is symmetrical about a horizontal plane. A

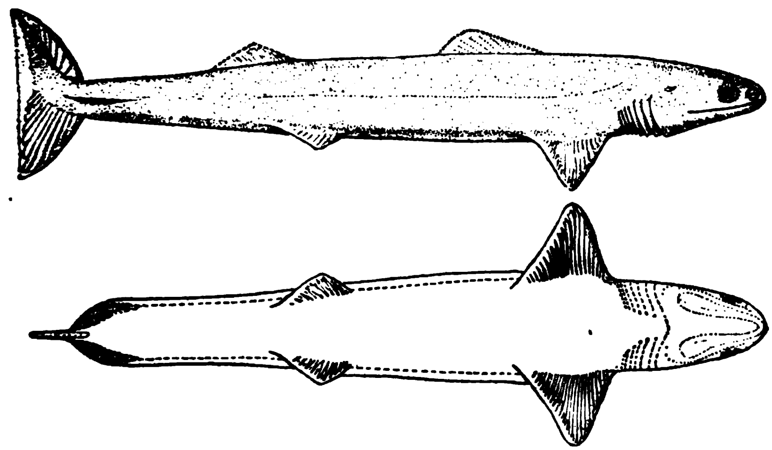

FIG. 10.—An extinct and archaic Shark, *Cladoselache fyleri*, side and ventral views, restored.
(From Bridge, Camb. Nat. Hist., vii, 1904, after B. Dean.)

short dermal expansion forms a horizontal keel on each side of the base of the tail. No calcifications are recognisable in the sheath of the notochord; the skeletal cartilages are calcified in the form of cubes, closely fitting like a mosaic. The teeth are of various forms, each with a principal cusp and a variable number of lateral cusps. The eye has a ring of small dermal plates; the remainder of the body is covered with minute denticles.

ACANTHODIDES (Acanthodian Sharks).

Climatius.

The Acanthodian fishes are Palæozoic Sharks of small size, rarely exceeding one foot in length. The restoration of *Climatius* shown (11) is about four times the natural size (linear). The

placoids of the skin are flattened and closely fitted together. The calcifications of the cranium, jaws, and pectoral girdle present the appearance of membrane bones, although bone cells are wanting. The fins, both paired and median (except the caudal), bear each a stout spine along the front edge, and in some cases there occur between the pectoral and pelvic fin of each side a row of four or five spines of a similar nature (see 11, and fig. 11). The cartilaginous supports of the fins must have been insignificant, and the fin-membranes but feebly supported by dermal fin-rays. The earlier forms, those of the Upper Silurian and Lower Devonian, are included in the family Diplacanthidæ (e.g. *Diplacanthus* and *Climatius*); these have two dorsal fins. The family Acanthodidæ (e.g. *Acanthodes*) includes the later forms, those ranging from the Lower Devonian to the Lower Permian, which have but a single dorsal fin, and pelvic fins of smaller size than the pectorals. In *Climatius* (11) the fin-spines are remarkably broad, and are marked with coarse longitudinal ridges. The most perfect specimens known are about seven inches in length, but fragments have been found of specimens which must have measured eighteen inches or more when complete.

SELACHII (Modern Sharks and Rays).

The order Selachii includes all the modern Sharks and Rays, and a number of extinct forms as well. The great majority of the Selachii are marine, but a few species live in fresh water. The denticles of the skin are closely set to form shagreen, but in the Rays there is a tendency for the spines to become fewer and larger. The calcifications on the surface of the cartilages do not resemble membrane bones, and have not the microscopic structure of true bone. The basal cartilages of the pectoral fin, namely, those in contact with the pectoral girdle, are usually three in number, less commonly two; there is no long segmented axis to the fin. With a few exceptions the vertebral centra are well calcified, but the form of the calcified layers varies considerably (compare specimens 20, 28, 65, 80, 85, 90, 113 in Wall-cases 1–4). The Selachii range back to Carboniferous and Permian times. The suborders recognised are:—Notidani, Squali, and Raii.

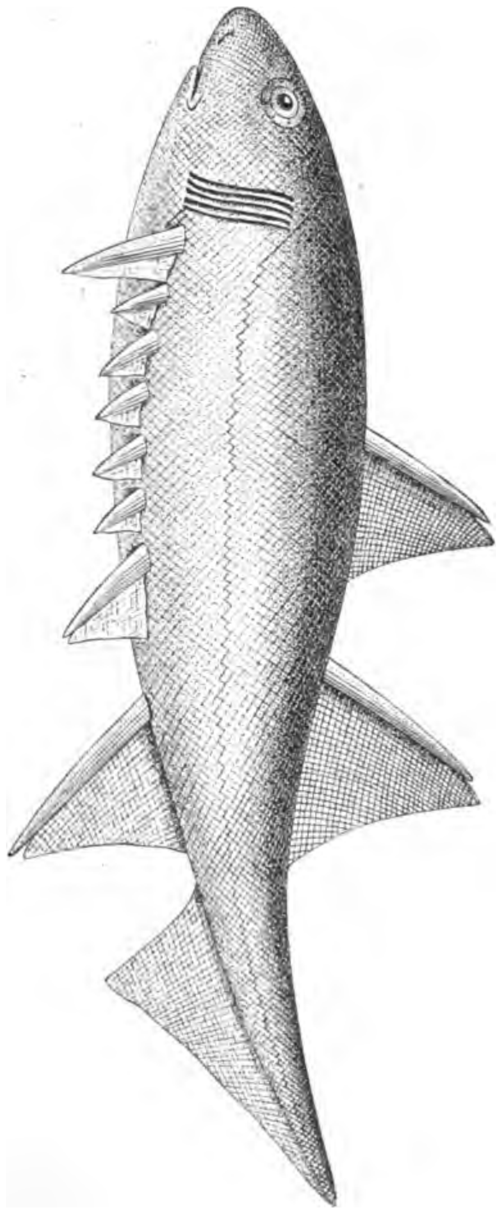

Fig. 11.—An Acanthodian Shark, *Climatius macnicoli*, restored.

NOTIDANI (Notidanid Sharks).

The Notidani constitute a small suborder of archaic Sharks in which the gill-openings are six or seven on each side of the body. The vertebral column is imperfectly segmented, and the centra are feebly if at all calcified; there is but a single dorsal fin, which is set rather far back, opposite the anal fin. There is no nictitating membrane or third eyelid, such as occurs in some Sharks (*e. g.* 67, Wall-case 2). There are two families, the Chlamydoselachidæ and the Notidanidæ.

Chlamydoselachus.

The family Chlamydoselachidæ includes but a single genus, *Chlamydoselachus*, a long, slender-bodied Shark (specimen 12, and fig. 12) found in the deep seas of many parts of the world, and first obtained off the coast of Japan in 1884. The head is depressed, and the mouth is terminal. There are six pairs of gill-openings, with backwardly directed frills or flaps of skin, whence the popular name "Frilled Shark" given to this fish. The skull is hyostylic, *i. e.* the jaws are suspended from the cranium by means of the upper element of the hyoid arch (for illustration of "hyostylic" see specimen 18). The teeth are of primitive character and several rows are simultaneously in use; the crown consists of three slender curved cusps, separated by a pair of small denticles; the embedded bases are broad and backwardly extended, and overlap one another in the gum.

Notidanus.

In the Notidanidæ the skull differs from that of the previous family in being "amphistylic," *i. e.* the jaws are connected with the cranium or brain-case in two ways, by a direct articulation between the upper jaw and the optic region of the cranium, and by means of the hyomandibular cartilage, or upper piece of the

FIG. 12. - Frilled Shark, *Chlamydoselachus anguineus.*

hyoid arch, which is much more slender than is usual in Sharks (see skull of *Notidanus*, 13, and compare with the hyostylic skull of *Scyllium*, 18). The mouth is inferior; the gill-clefts are six in number on each side in *Hexanchus* and seven in *Heptanchus*; there are no flaps or frills over the gill-clefts. The teeth have a characteristic form (see 15, and fig. 13), and in the lower jaw only one row of them is in use at a time. The principal teeth in their most perfect development possess a number of backwardly-sloping compressed cusps arising from a long base; the anterior edge of the first cusp is finely serrated. The teeth at the front of the upper jaw are smaller, and have each a single awl-shaped cusp with one or more small lateral cusps. The teeth of *Notidanus* are found in rocks as old as the Jurassic; examples are shown (16 A and B) of fossil teeth of Tertiary age. The Notidanid Sharks attain to a length of fifteen feet, and are distributed over the tropical and sub-tropical seas. In Wall-case 1 is shown a small specimen of the Perlon or Seven-gilled Shark, *Notidanus* (*Heptanchus*) *indicus*, 14, and suspended from the rail in front of the case is a Grey Shark, or Six-gilled Shark, *Notidanus* (*Hexanchus*) *griseus*, 1141, caught off the Orkney Isles.

FIG. 13.—Tooth of *Notidanus gigas*.

SQUALI (Sharks and Dog-fishes).

In the suborder Squali are included all the Sharks and Dog-fishes except the few embraced in the former suborder, the Notidani. There are two dorsal fins instead of one and the gill-clefts are five in number on each side. These fishes differ from those of the following suborder, the Raii (Wall-case 3), in the gill-clefts being laterally placed, and in the body being of the usual Shark type, without any great enlargement of the pectoral fins or flattening of the body. The Rhinidæ show a tendency to modification in these directions, although they do not necessarily lead on to the Rays. It is convenient to divide the suborder into two groups, which may be designated Group A and Group B.

Group A of Squali.

In the fishes of Group A an anal fin is present between the cloaca and the tail fin, and there is a tendency for the spiracle to become reduced in size. The vertebral centra are astero-spondylic, *i. e.* if viewed in transverse section they are seen to be strengthened by calcified ridges or radiating laminæ which predominate over the concentrically disposed laminæ (compare the asterospondylic vertebræ of *Cestracion* (20) and *Scyllium* (28) with the tecto-spondylic vertebræ of *Rhina* (90, Wall-case 2). Group A

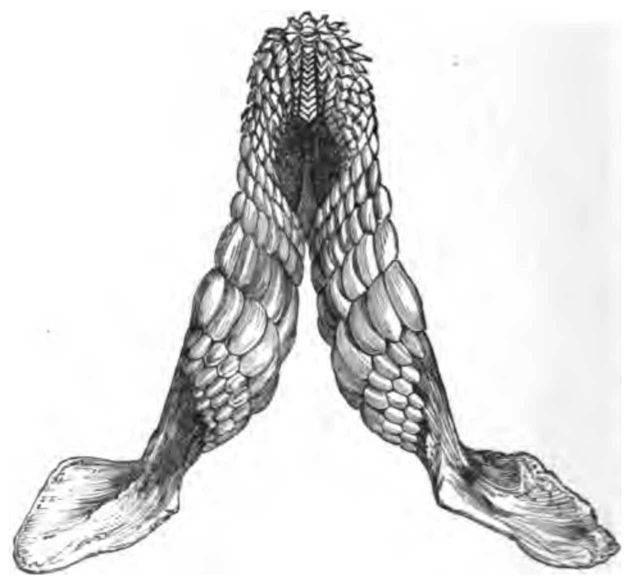

FIG. 14.—Upper jaw of Port Jackson Shark, *Cestracion philippi.* (From Günther, "Study of Fishes.")

includes the families Cestraciontidæ, Cochliodontidæ, Scylliidæ, Lamnidæ, Rhinodontidæ, and Carchariidæ.

Port Jackson Shark.

In the family Cestraciontidæ, the best-known example of which is the Port Jackson Shark (24), each of the two dorsal fins is armed with a stout spine (see spine, 24 A), and the first dorsal fin is opposite the space between the pectoral and pelvic fins. The nasal and buccal cavities are confluent; there is no nictitating membrane; the teeth, except those at the front of the mouth, are blunt, and adapted for crushing the shells of molluscs and crustaceans (see jaws, 19, and fig. 14). Sharks of this family

existed in Carboniferous times and were more numerous in Palæozoic and Mesozoic periods than at the present day.

In *Cestracion* the mouth is rather narrow and nearly terminal. The spiracle is small and situated below the posterior part of the eye; the gill openings are rather small. The dorsal fin-spines are smooth and with no posterior serrations such as occur in *Hybodus* (see spine, 21, and fig. 15). The jaws are suspended by the hyomandibular cartilage, but the upper jaw also enters into extensive articulation with the ethmoid region of the cranium (see skull of *Cestracion galeatus*, 17; the more usual type of hyostylic skull found in Sharks is illustrated by a skull of *Scyllium*, 18). The vertebral centra of *Cestracion* are asterospondylic (see 20), but the radiating arrangement of the secondary laminæ of calcareous matter does not occur in the more ancient genera of the family, e. g. *Hybodus* and *Palæospinax*. The egg-shell of *Cestracion* has a curious spiral flange projecting from its surface (see 6).

FIG. 15.—Dorsal fin-spine of *Hybodus*. (From Günther, "Study of Fishes.")

The species of *Cestracion* occur in the seas of Australia, Japan, California, &c. The specimen 24 shown in Wall-case 1 is a small example of the Port Jackson Shark; a larger specimen (four feet long) is shown in the Table-case 23, in the centre line of the Gallery; a full-sized individual is about five feet long. For comparison with the teeth of *Cestracion* (19) are shown the teeth of the extinct *Acrodus* (22) and *Asteracanthus* (23).

The Sharks of the family Cochliodontidæ flourished in Carboniferous times, and their remains are practically confined to the rocks of that age. The dentition differs from that of the Cestraciontidæ in one or more of the transverse series of teeth being fused into a continuous curved plate. Whereas in *Cestracion* the reserve members of the series of crushing teeth arise as separate teeth on the lingual or inner Cochliodus.

side of those in use, in *Cochliodus* the teeth are coalesced into a continuous plate, which receives additions to its lingual border and slowly moves outward and forward in a spiral manner over the surface of the jaw. Two views are given of the dental scroll of *Cochliodus*, 25 and 26 (see also fig. 16).

In the family Scylliidæ the dorsal fins have no spines; the first is situated above or behind the pelvic fins. The spiracle is distinct; there is no nictitating membrane. The teeth are small and several series are in use at the same time. The nasal and buccal cavities are more or less confluent; the fourth and fifth gill-slits are close together in the genera *Chiloscyllium*, *Crossorhinus*, *Ginglymostoma*, and *Stegostoma*, but not in *Scyllium*.

FIG. 16.—Jaw with tooth-plates of *Cochliodus contortus*. (From Günther, "Study of Fishes.")

Dog-fishes. The common Dog-fish of the South coast of England is *Scyllium canicula*, 30. The term "Dog-fish" is applied loosely to any small Shark-like fish, the difference between a Dog-fish and a Shark being one of size only*. The Dog-fishes found around the British coast include the one just mentioned, *Scyllium canicula*, 30, the Smaller Spotted Dog-fish; the Larger Spotted Dog-fish or Nurse Hound, *Scyllium catulus*, 27; and the following three which do not belong to the family at present under consideration, the Piked Dog-fish, *Acanthias vulgaris* (75, in Wall-case 2), a Dog-fish which on the East coast is more common than the Spotted Dog-fish; the Smooth Hound, *Mustelus vulgaris* (68, Wall-case 2), and the Tope, *Galeus canis* (64, Wall-case 2). The commonest of these are the Smaller Spotted Dog-fish and the Piked Dog-fish, which in some parts of the coast are sufficiently plentiful to prove troublesome to fishermen by taking the bait intended for more valuable fish.

Spotted Dog-fish. The Spotted Dog-fishes are ground feeders and live mostly on crustaceans and molluscs, and they keep fairly close to the land. On some parts of the coast these Dog-fishes are eaten, but the flesh is not in great favour. The smaller Dog-fish is distinguished from

* This does not apply to extinct forms. Acanthodian fishes, for instance, rarely exceed a foot in length, but it is customary to speak of them as "Sharks."

the larger, not only by its smaller size, but by its anal fin being situated farther forward as compared with the second dorsal fin, and the right and left nasal flaps are nearly continuous in front of the mouth, whereas in *Scyllium catulus* they are some distance apart. These Dog-fishes lay pillow-shaped eggs with a flexible yellow-brown or black egg-shell, the four corners of which are produced into tendril-like threads which serve to anchor the egg to sea-weed and rocks (see specimen 4 in the introductory series below the label "Elasmobranchii"). Two eggs are laid at a time, and five or six months elapse before the embryo fish hatches out.

The Black-mouthed Dog-fish, *Pristiurus melanostomus*, 31, is a small Dog-fish common in the Mediterranean and occasionally caught in British seas; it has a series of small flat spines on each side of the upper edge of the tail fin. The genus *Ginglymostoma* includes Sharks some of which grow to twelve feet in length, with small eyes and minute spiracles; they are of pelagic habit and occur in the warmer parts of the Atlantic and Indian Oceans. The specimen of *Ginglymostoma brevicaudatum* shown (33) is small, the jaws of the same species (34) give an idea of the size to which the fish grows. A specimen of *Ginglymostoma cirrhatum* (36) is shown on the floor of the case, and another specimen hangs from the rail opposite Wall-case 2.

In *Chiloscyllium* (e. g. *Chiloscyllium indicum*, 35) the anal fin is far behind the second dorsal, and is almost continuous with the caudal fin; the genus includes several species of small Dog-fishes occurring in the Indian Ocean and adjacent seas. *Stegostoma* resembles *Chiloscyllium* in the backward situation of the anal fin, but the spiracle is behind the eye instead of below it; the eye is very small, the snout very blunt, and the upper lip thick. The Zebra Shark, *Stegostoma tigrinum*, is one of the commonest Sharks of the Indian Ocean. In the young (e. g. 38) the tail fin is proportionately much larger than in the adult (37), and the colour-markings are more pronounced. This last feature is not uncommon in Elasmobranch fishes, the young of many Dog-fishes, Sharks, and Rays being brightly banded or spotted, whereas the adults are of a uniform and dull coloration. *Crossorhinus* (39) has a broad, flat head with blunt snout and lateral projections of skin; the mouth is wide and nearly terminal; the eye is small and

Zebra Shark.

the spiracle is a wide slit behind the eye. These fishes are ground Sharks occurring off the coasts of Japan, Australia, &c., and attaining a length of ten feet.

In the Lamnid Sharks (family Lamnidæ) the dorsal fins are without spines, and the first is situated opposite to the space between the pectoral and pelvic fins. There is no nictitating membrane; the gill openings are generally large; the spiracle is minute or absent. The teeth are large and cuspidate and the bases are compressed antero-posteriorly, and thus differ from the

FIG. 17.—Porbeagle Shark, *Lamna cornubica.*

stout depressed bases of the teeth in the more ancient Sharks, such as those already considered. The teeth are solid when completely formed. The Lamnid Sharks attain to a large size and are pelagic in habit.

Porbeagle. The Porbeagle Shark, *Lamna cornubica* (fig. 17) grows to ten feet in length and is occasionally caught off the British coasts; the specimen which hangs from the top of Wall-case 1 (specimen 40) was caught at Skye. The Mackerel Shark, *Lamna spallanzanii*, differs but little from the Porbeagle; the jaws of this Shark are exhibited (41), and a cast of a specimen caught on the Atlantic coast of North America is shown on Table 25 in the middle of the other end of the Gallery. The teeth are large and lanceolate and serve merely for seizing the fishes upon which these Sharks prey.

Great Blue Shark. In *Carcharodon* the teeth are large, erect, triangular and serrated along the edge (see jaws 44). The most formidable of modern Sharks belong to the genus *Carcharodon*. A Great Blue Shark or Man-eater Shark, *Carcharodon rondeletii*, is shown on Table 25 at the other end of the Gallery, also the jaws of a much larger specimen, similar to the jaws in Wall-Case 1. The Great Blue Shark is known to grow to forty feet in length;

some of the extinct species of *Carcharodon* must have been vastly larger, judging by the great size of the teeth (e. g. 43) that are found in Eocene, Miocene, and Pliocene strata.

Thresher.

The Thresher or Fox Shark, *Alopecias vulpes* (1139, hanging from

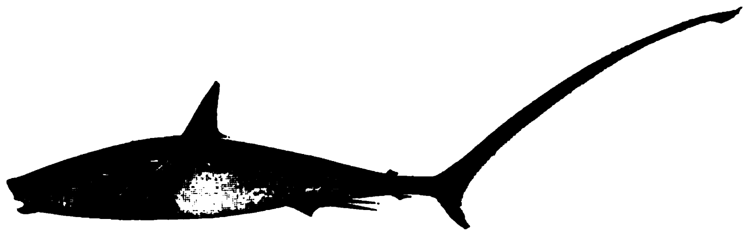

FIG. 18.—Thresher Shark, *Alopecias vulpes.*

the rail opposite Wall-Case 3, and fig. 18), has an extremely long tail fin, and has not the paired longitudinal keel at the side of the tail that is present in the Sharks of the two preceding genera. The Thresher is common on the British coasts; it feeds on Herrings, Pilchards, and Sprats, and attains to a length of fifteen feet, one half of which is taken up by the tail.

In the genus *Odontaspis* (46, and specimen 1123, hanging from the rail opposite Wall-case 20) the second dorsal fin and the anal fin are not so reduced in size as they are in the genera *Lamna, Carcharodon* and *Alopecias,* and there is no tip on the upper surface of the root of the tail. The teeth are long and lanceolate, with one or two small cusps at the base of the main cusp (see jaws 47, and fig. 19).

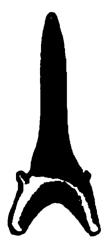

FIG. 19. Tooth of *Odontaspis elegans.*

Elfin Shark.

The Elfin Shark, *Mitsukurina owstoni,* is closely allied to *Odontaspis,* but differs in the shape of the snout, which projects beyond the jaws to a considerable extent (see 1124, hanging from the rail opposite Wall-case 19). It is even more closely allied to the extinct *Scapanorhynchus* of the Upper Cretaceous strata of Syria. The Elfin Shark is a deep-sea Shark first caught in the year 1898 in the seas of Japan. The tail is longer than that of *Odontaspis* and is nearly in a line with the body. The Shark grows to about twelve feet in length.

Basking Shark.

The Basking Shark, *Selache maxima* or *Cetorhinus maximus* (see fig. 2, p. 8), is a great Shark growing to 33 feet or more, and widely distributed in northern seas. In Wall-case 1 the Shark

is represented by a sketch of a 28 foot specimen caught off the Isle of Wight in 1875, a photograph of a young specimen 11 feet long caught off Brighton in 1903, showing the disproportionately large snout characteristic of young specimens, and a piece of skin prepared to show the manner in which the small, pointed denticles are arranged in patches or groups. Hanging from the roof is a specimen of the Basking Shark, 28 feet long, caught off Bergen in 1904, and below it on the floor is a cast of the skeleton of a specimen of the same size and from the same locality. Within the same enclosure are the head and pelvic fins of the Isle of Wight specimen mentioned above. For further information concerning these specimens see page 9.

Whale Shark. The family Rhinodontidæ is a small one, including only the Whale Shark, *Rhinodon typicus*, of which a small specimen is shown suspended from the roof at the other end of the Gallery (see page 10 in the chapter on "Central Exhibits"). A sketch of the Shark (52) is shown in Wall-case 1, also a piece of the dental ribbon (53). The Whale Shark is the largest Shark living at the present day, and attains a length of 50 or 60 feet. It is widely distributed and occurs mainly in the Indian and Pacific Oceans. The snout is flattened, the mouth nearly terminal, the gill-slits of moderate size, the first dorsal fin set above the pelvic fins, and the eyes and the teeth very small. The last gill-slit is above the base of the pectoral fin, whereas in the preceding family, the Lamnidæ, it is in advance of the fin.

Wall-case 2. The Sharks of the family Carchariidæ have no spines in the dorsal fins, and the first dorsal fin is situated opposite to the space between the pectoral and pelvic fins. The mouth is crescent-shaped and inferior, and the eye is provided with a nictitating membrane or third eyelid which can be drawn over the exposed part of the eyeball (see 67). The teeth are usually large and cuspidate, and are hollow when completely formed (*cf.* Lamnidæ). No remains of undoubted Carchariid Sharks occur in strata below the Eocene. In *Carcharias* itself the spiracle is absent; there is a pit at the root of the caudal fin, which has a distinct lower lobe; the teeth have a single sharp cusp, mostly compressed and triangular, and the upper teeth usually differ much from the lower. Most of the Sharks of this genus occur in tropical

seas; the average size is twelve or fifteen feet, but some species attain to a length of twenty-five feet.

Carcharias.

The common Blue Shark, so dangerous to persons bathing in the tropics, is *Carcharias glaucus*. The genus is represented in the exhibited series by the White Shark, *Carcharias lamia*, 57; the Black-finned Shark, *Carcharias melanopterus*, 58; *Carcharias menisorrah*, 60; the jaws of *Carcharias acutidens*, 61, and *Carcharias dussumieri*, 59; and a specimen of *Carcharias hemiodon*, 1125, suspended from the rail opposite Wall-case 18. In some parts of India and China Shark's fins are used for making soup, the fins being mostly those of Carchariid Sharks. They are sold in the form in which they are exhibited (specimen 70). The trade in Shark's fins is less now than formerly; in the year 1845 over four hundred tons of them were exported from Bombay to China.

Galeocerdo.

In the genus *Galeocerdo* the spiracle is minute; there are pits at the root of the caudal fin, one above and one below. In the terminal lobe of the caudal fin there is a notch, situated

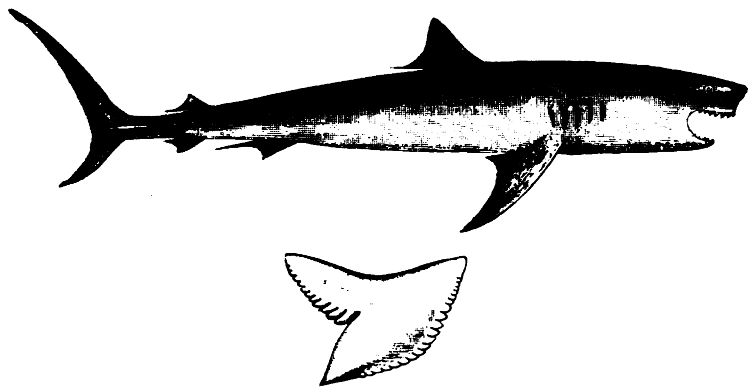

FIG. 20.—*Galeocerdo arcticus*, a Shark of wide distribution. Also a single tooth of the same Shark.

at the point where the vertebral column ends, which is not present in the other genera of the family. The teeth are subequal in the upper and lower jaws; they are oblique, serrated on both margins, and have a deep notch on the outer or posterior margin (see teeth 63 and fig. 20). A small specimen of the Tiger Shark, *Galeocerdo tigrinus*, 62, is shown; hanging from the rail opposite

Wall-case 17 is a fairly large specimen of *Galeocerdo rayneri* (1127) from the Indian Ocean, also the jaws of another specimen (1126).

Tope. The Tope, *Galeus canis*, 64, is a fish not uncommon on the British coasts, and widely distributed in tropical and temperate seas. It is a bottom-feeder, with a fairly long snout; the spiracle is minute, and there is no pit at the root of the tail. The jaws of the Tope are exhibited (66) and the calcified parts of the vertebral centra showing the cruciform pattern of the secondary calcification (65). The Smooth Hound, *Mustelus vulgaris*, 68, differs from the Tope in having closely set, flattened teeth, arranged like a pavement (see jaws 69). It is a fish commonly found in British seas; the species *Mustelus lævis* is occasionally met with also, but it has a more southern distribution than *Mustelus vulgaris*.

Hammer-head Shark. The Hammer-head Shark, *Zygæna malleus*, is a strange-looking Shark in which the anterior part of the head is broad, flattened, and laterally elongated; the eyes are situated at the extremities of the lobes, and the nostrils occur just beneath the front edge; the spiracle is absent; the teeth are similar in the upper and lower jaws, they are oblique and have a posterior notch and margins smooth or serrated. The Hammer-head Sharks are found in most temperate and tropical seas. The specimen 71 on the floor of Wall-case 2 is a small one; a larger example (1129) hangs from the rail opposite Wall-case 16; the jaws of a Hammer-head (1128) are shown near the latter specimen.

Group B of Squali. In the fishes of Group B of the suborder Squali the spiracles are large, and the anal fin wanting. The line of the closed mouth is nearly straight, and not crescentic as is so commonly the case in the fishes of Group A. The calcification of the vertebral centra either takes the form of primitive hollow double-cones immediately surrounding the remnants of the notochord, or there are concentric secondary laminæ in addition. This group includes the families Spinacidæ, Petalodontidæ, Pristodontidæ, Rhinidæ and Pristiophoridæ.

Spinacidæ. The family Spinacidæ includes fishes, some of which, like *Spinax*, 79, and *Acanthias*, 75, are slender and shapely, while others, such as *Centrina*, 83, and *Echinorhinus*, 86, are bulky and clumsy in appearance. The dorsal fins are provided with spines in some genera (e. g. *Centrina, Acanthias*), but not in others (e. g. *Scymnus, Echinorhinus*). The body is rounded or triangular in

section; the mouth is gently arched and the snout obtuse. The pectoral fins are not notched at their bases, and are not produced forward. There is no nictitating membrane; the gill-slits are small and lateral in position. Remains of Sharks of the family Spinacidæ are not found in strata below the Upper Cretaceous.

Valentin's Sea-hound, *Scymnus lichia*, 73, is a fish common in the Mediterranean and on the coast of Portugal, and occasionally met with in the English Channel. The dorsal fins have no spines and the first is set well in advance of the pelvic fins. The upper teeth are small and pointed; the lower teeth are much larger than the upper teeth (see jaws 74), they are broad and compressed, triangular and erect, but slightly sloping in the young.

Piked Dog-fish.

The Piked Dog-fish or Spiny Dog-fish, *Acanthias vulgaris*, 75, has a spine in the anterior edge of each of the dorsal fins (see spines 76). The teeth are similar in the upper and lower jaws; they are rather small, triangular, and compressed, with the apex much turned aside, so that the inner margin of the tooth forms a cutting edge (see jaws 78). Although the tail fin is not symmetrical above and below the middle line the vertebral column is not uptilted (see tail 77). The Piked Dog-fish has a remarkable distribution, being found in the temperate seas of the northern and southern hemispheres, but not in the intermediate tropical region. It is one of the commonest Dog-fishes around the British coast, and causes much trouble to fishermen by cutting their lines and carrying away the hooks.

The Black Dog-fish, *Spinax niger*, 79, is a small Dog-fish found in most European seas, and common off Portugal and in the Mediterranean. This fish is apparently not black when alive; freshly taken specimens are very pale in colour (see sketch 98, in Cabinet-case 44, Deep-sea Fishes). The centra (see 80 in Wall-case 2) possess no secondary calcifications, but only the primitive double-cone calcification immediately surrounding the constricted notochord. This type of vertebra is termed 'cyclospondylic,' and is characteristic, among modern fishes, of the Spinacidæ, although it occurs in the more primitive extinct members of other families, *e. g.* in the Liassic genus *Palæospinax*, supposed to belong to the family Cestraciontidæ.

The genus *Centrophorus* includes deep-sea Sharks growing to about five feet in length. Most of them are caught off the coasts

of Portugal and Madeira. Each dorsal fin is provided with a spine, which, however, is sometimes so small as to be hidden below the skin. The mouth is wide; the lower teeth have the points inclined outward; the upper teeth are erect and triangular, or narrow and lanceolate, with a single cusp (see jaws 82). In *Centrina* (83) the trunk is rather elevated, triangular in section, with a thick fold of the skin extending along each side of the ventral surface. Each dorsal fin is provided with a strong spine, which is largely concealed in the substance of the fin. The teeth of the lower jaw are erect, triangular, and finely serrated; those of the upper jaw are slender and conical, and form a group at the front of the jaw (see jaws 84).

Spinous Shark.

The Spinous Shark, *Echinorhinus spinosus*, 86, has a short bulky body and a short tail. The dorsal fins are small and have no spines; the first dorsal is opposite to the pelvic fins. The teeth are equal in the upper and lower jaws; they are very oblique, the point being turned outward, and having one, two or three horizontally directed denticulations on each side. Embedded in the skin are scattered, flat, circular tubercles, each with a small central spine. The nostrils are midway between the mouth and the end of the snout; the spiracle is small. The Shark lives mostly in deep water; it occurs in the Mediterranean and the Eastern Atlantic.

Greenland Shark.

In the Greenland Shark, *Læmargus borealis* (sketch 87 and specimen 1138 hanging from the rail in front of Wall-case 4) all the fins are small; the dorsal fins are without spines, and the first is set at a considerable distance in advance of the pelvic fins. The nostrils are near the extremity of the snout; the jaws are feeble; the shagreen is uniform. The upper teeth are small, narrow, and conical; the lower teeth are numerous, each with the point so much turned aside that the inner margin forms a cutting edge. The Greenland Shark is an inhabitant of the Arctic regions and grows to a length of fifteen feet. Although harmless to man it attacks Whales and bites pieces out of their sides.

Angel-fish.

The Angel-fish or Monk-fish, *Rhina squatina*, 88, is the sole living species of the family Rhinidæ; the genus is represented in the Lithographic Stone (Upper Jurassic) of Bavaria, where complete skeletons occur. The mouth is anterior and the gill-openings wide and lateral in position. The depression of the body

and the large size of the pectoral fins, and the forward production of their bases towards (but not reaching) the head, suggest an approach to the members of the next suborder, the Raii, although the indication is probably fallacious. The dorsal fins are without spines, and are set upon the tail part of the body. Small tubercles occur embedded in the skin; the teeth are conical and pointed (see jaws 91); the vertebræ (see vertebræ 90) are tecto-spondylic, this term signifying that of the secondary calcified laminæ on the outside of the primary double-cone calcification immediately around the constricted notochord, the concentric laminæ preponderate over the radiating laminæ. In the Angel-fish the concentric laminæ are very numerous and closely set; in the extinct species they are less numerous. This type of vertebra occurs also in the Saw-fishes and Rays, though in a less pronounced form (see vertebra of *Raia*, 113, Wall-case 3). The Angel-fish grows to a length of five feet, and is wide-spread throughout the tropical and temperate seas.

The Petalodontidæ (represented by teeth of *Petalodus*, 92, and *Polyrhizodus*, 93) are extinct fishes, allied to the Angel-fish, which flourished in Carboniferous and Permian times. The body was moderately depressed, the pectoral fins large and continued forward towards the head. The teeth were compressed antero-posteriorly, and formed a close pavement over the surface of the jaw.

Pristiophorus.

In *Pristiophorus*, 94, the sole genus of the family Pristiophoridæ, the elongation of the snout to form a rostrum, and the presence of teeth along its edges, suggest an affinity with the Pristidæ or Saw-fishes, the first family of the next suborder, but the body is scarcely depressed, the gill-slits are lateral in position, the pectoral fins are of moderate size, and their bases show no tendency to spread towards the head. On the other hand, the enlargement of the prepalatine cartilages of the skull which is observed in the Pristiophoridæ is a feature which in the Rays is definitely associated with the extension of the front of the pectoral fin around the edge of the head. A pair of long barbels occur on the under-side of the 'saw.' The teeth of the mouth are small, with a conical cusp on a broad base. These fishes occur in the seas of Japan and Australia, and attain to no great size.

Raii (Saw-fishes and Rays).

Wall-case 3.

The suborder Raii or Batoidei includes the Saw-fishes, Skates, and Rays. The form of the body is adapted for living on the sea-bottom; the pectoral fins are enlarged, and their front edges encroach round the sides of the head; the tail and median fins are reduced, although these characters are less pronounced in the first two families—the Pristidæ and Rhinobatidæ—than in those that follow. In the more highly specialised forms the trunk, surrounded by the immensely developed pectoral fins, forms a broad, flat disc, of which the tail appears as a slender appendage (see Sting Rays, Wall-case 4). The cartilaginous rays of the fins are greatly developed and the dermal fin-rays reduced or absent. The eyes and spiracles are on the upper surface of the body, and the five pairs of gill openings on the under surface (see *Raia*, 112). The upper surface is pigmented, the lower pale. The Rays lead a sedentary life at the bottom of the sea and subsist on molluscs, crustaceans, and small fishes; they keep fairly near the coast, only the Eagle Rays being found in the open ocean. Some species occur in fresh water. In the more highly specialised forms progression is effected by the gentle undulation of the long margin of the pectoral fin, and not by a flapping of the whole fin, nor by the lashing of the tail. The mouth opening is ventral, and very slightly if at all curved, and the jaws are correspondingly straight and transverse. The jaws are rounded in section, and several rows of teeth are in use at the same time (see jaws 103 and 116). In the highly specialised Eagle Rays the teeth are flattened plates adapted for crushing (see jaws 122 and 126).

Saw-fishes.

The Pristidæ, or Saw-fishes, are distinguished by the remarkable prolongation of the rostrum of the skull, with its double 'saw' of lateral teeth (see fig. 21). In other respects the Pristidæ may be regarded as the least modified of the Batoidei or Raii; they swim freely, and have a body which is long, slightly depressed, and passing gradually into the strong and muscular tail. Although the pectoral fins have grown forward so far as to turn the gill-clefts on to the ventral surface of the body they are not very greatly enlarged. The dorsal fins have no spines; the first is

opposite to the base of the pelvic fins, or nearly so. Remains of the genus *Pristis* are found in Eocene deposits.

The Saw-fishes shown are *Pristis cuspidatus*, 100, in Wall-case 3, *Pristis pectinatus*, 1137, hanging from the rail opposite Wall-case 5, and a large *Pristis perrotteti*, 1120, hanging from the

Fig. 21.—Lower view of head of Saw-fish.

roof between Wall-cases 2 and 19. Rostral saws of *Pristis sagittatus*, 99, and *Pristis perrotteti*, 98, are shown in Wall-case 3, and saws of *Pristis zysron*, 1142, and *Pristis antiquorum*, 1143, on the wall between Wall-cases 2 and 3. Saw-fishes are found in tropical and to a less extent in subtropical seas. They attain to a considerable size, the 'saws' of some species measuring six feet in length. The saw is a powerful weapon of attack and is used to rip up the body of some large fish or Whale ; the teeth

of the jaws are minute and obtuse, and merely serve to seize the pieces of flesh left projecting from the body of the animal attacked.

The endoskeleton of the rostral saw of the Saw-fish consists of a variable number (usually three) of long tapering tubes (see specimen 101), encrusted with granular calcifications similar to those found upon the other cartilages of the skull. One of these tubes, found detached, remained for a long time a puzzle to naturalists, and was even described in 1864 as the arm of a kind of Star-fish, to which the name *Myriosteon higginsii* was given.

Rhino-batidæ.

In the Rhinobatidæ, as in the Pristidæ, the tail is long and powerful; it is provided with two large dorsal fins, without spines, and has a longitudinal fold along each side. The caudal fin is well developed. The trunk is not greatly expanded and the head is not embraced by the pectoral fins. The family is represented by well-preserved skeletons in the Lithographic Stone (Upper Jurassic). Of the recent genera, *Rhynchobatus* and *Rhinobatus* are the most important. In *Rhynchobatus djeddensis* (104) the snout is narrower and more pointed than in *Rhynchobatus ancylostomus* (102), and the calcareous tubercles on the back are smaller; the undulation of the toothed surface of the jaw is less marked (compare jaws 105 and 103). *Rhinobatus* (e. g. *Rhinobatus granulatus*, 106) differs from *Rhynchobatus* in having the dorsal fins set farther back, and in the caudal fin having no lower lobe; the front of the skull is produced into a rostrum, and the space between the side of the rostrum and the front part of the pectoral fin is filled by skin. The teeth are obtuse, with an indistinct transverse ridge (see jaws 107). *Rhinobatus granulatus* occurs in the Indian seas: *R. lentiginosus* is common off Florida, where it is known as the Guitar-fish. *Trygonorhina*, 108, is an Australian genus.

Skates and Rays.

In the Raiidæ (Skates and Rays) the disc is broad, rhombic, and generally with dermal asperities or spines. The pectoral fins extend to the snout. The tail has a longitudinal fold on each side, and does not bear barbed spines such as occur in the Sting Rays (Wall-case 4). There is a rudimentary electric organ in the tail. In the Thornback and some other species of *Raia* the teeth are pointed in the male, but blunt and flattened in the female (see 116 and 117). The fishes of the genus *Raia* have a wide geographical

range, but are commonest in the temperate seas, and are more numerous in the northern than in the southern hemisphere. The British species are:—Thornback, *Raia clavata*, 109; Homelyn Ray, *R. maculata*; Starry Ray, *R. radiata*; Sandy Ray, *R. circularis*, 115; Common Skate, *R. batis*, 112; Burton Skate, *R. marginata* (see specimen 1079 on the floor beneath the tail of the skeleton of the Basking Shark, within the mahogany rail in the middle of the Gallery); Shagreen Ray, *R. fullonica*; Flapper Skate, *R. macrorhynchus*; Sharp-nosed Skate, *R. oxyrhynchus*, 111; Owl Ray, *R. microcellata*. Some of the Skates attain to a considerable size, the disc of large specimens measuring six or seven feet across. All of the species of *Raia* are marketable fish. The genus dates back to the Upper Cretaceous.

The Thornback, *Raia clavata*, 109, has, in addition to the small asperities of the skin, large, curved spines, with very large embedded bases, arranged on the back and tail (see 110). The specimen of the Common Skate, *Raia batis*, 112, mounted to present its under surface, shows well the paleness of the skin as contrasted with the colouring of the skin of the upper surface (compare with the Sharp-nosed Skate, 111); it also shows the mouth as a transverse cleft, set at some distance from the front of the disc, and the five pairs of gill-slits arranged symmetrically near the middle of the under side of the disc. The eyes and spiracles of Skates are on the upper surface (see 111). The eggs of Skates are pillow-shaped, with a process at each of the four corners; in colour they are brown or black. Empty egg-shells are often to be seen on the beach after a storm (see 114).

Eagle Rays.

In the Myliobatidæ, a family which includes the Eagle Rays and Sea-devils or Devil-fishes, the pectoral fins are of very large size; they are interrupted at the sides of the head, but reappear as either one or two small cephalic fins at the front of the snout. The tail is very slender; the cleft of the mouth is straight, and the dentition is in the form of a triturating mosaic-work or pavement, in some cases strongly arched in an antero-posterior direction.

Devil-fish.

The various species of *Dicerobatis*, the Devil-fishes, are the largest of the Rays; some specimens measure 15 feet across, and weigh over 1000 lbs. A specimen of *Dicerobatis eregoodoo* measuring 9 feet across is suspended from the roof between Wall-cases 6 and

15; the young specimen 121 exhibited in Wall-case 3 shows equally well the great breadth of the pectoral fins, the pair of cephalic appendages pointing forwards, and the slender tail. The Devil-fishes are mostly found in the tropics, but one species, the Ox Ray or Horned Ray, *Dicerobatis giornæ,* occurs in the Mediterranean and adjacent parts of the Atlantic.

Bishop Ray. The Bishop Ray, *Aëtobatis narinari,* is represented by a large specimen suspended from the roof between Wall-cases 5 and 16, and a pair of jaws (122) on the floor of Wall-case 3; the teeth are flat, broad, and in a single series running antero-posteriorly. In *Rhinoptera* the teeth are arranged in five or more series (123),

FIG. 22.—Eagle-Ray, *Myliobatis aquila.*

the middle series being the largest, except in young specimens. In the Eagle Ray, *Myliobatis aquila* (fig. 22), of which a specimen is shown (125), the teeth are arranged in seven series (126, and fig. 23); those of the three lateral rows are narrow, but the middle teeth are broad and increase in breadth as age

advances. The condition found in *Aëtobatis* (122), where there are no marginal teeth, thus marks but a further step in the same direction of specialisation. In the Devil-fish, on the other hand,

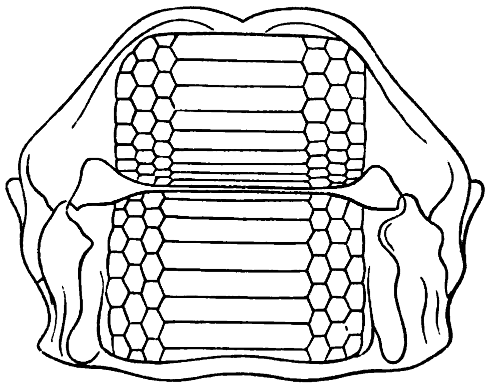

FIG. 23.—Jaws of Eagle-Ray, *Myliobatis aquila*, seen from behind. (From Günther, "Study of Fishes.")

the teeth are numerous and small. In the extinct (Cretaceous) genus ***Ptychodus*** the teeth are quadrate in form, with an elevated crown sharply separated from the root (124 A and B). The crown has a series of transverse or radiating ridges, surrounded by a more finely corrugated marginal area.

In the Torpedinidæ or Electric Rays (fig. 24, p. 46) the disc is broad, and the skin smooth and soft. The tail has a longitudinal fold on each side; the caudal fin is present and usually two dorsal fins also. The skeleton of the pectoral fin is not continued forwards beyond the base of the snout. An electric organ capable of giving an electric shock is present between the head and the pectoral fin of each side. The organ (see 120) consists of closely-set hexagonal prisms, vertically disposed, and terminating against the skin of the upper and under surfaces of the body. The electric organ is supplied by branches of the fifth and tenth cranial nerves (trigeminus and vagus). The Torpedo occurs in the Mediterranean Sea and the Indian and Atlantic Oceans (e. g. *Torpedo marmorata*, 119, and fig. 24); one species (*Torpedo hebetans*) is occasionally found off the coast of England (see specimen 1080 on the floor beneath the tail of the skeleton of the Basking Shark, within the

Electric Ray.

mahogany rail in the middle of the Gallery). The maximum breadth attained by the Torpedo is about three feet, and a fish of this size can by its electric discharge disable a man.

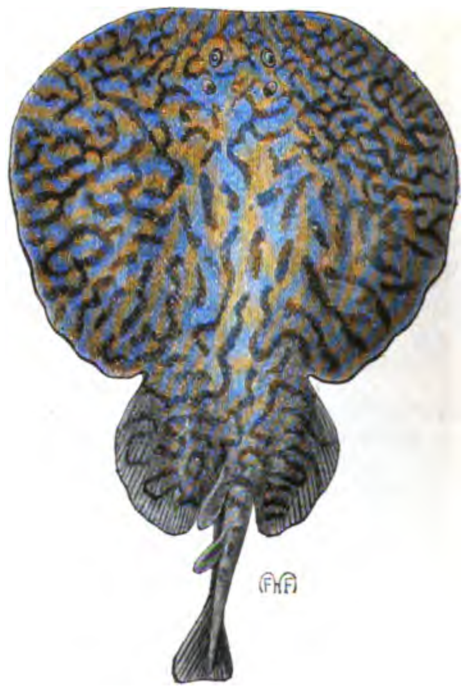

FIG. 24.—Electric Ray, *Torpedo marmorata.*

Wall-case 4. The Sting Rays or Trygonidæ (fig. 25) have the pectoral fins continued along the sides of the snout and confluent at its extremity. The tail is slender and sharply marked off from the disc, and has no lateral fold. The dorsal and caudal fins are absent, or are feebly developed. A strong spine, barbed along its sides, occurs on the upper part of the tail; the spine is shed from time to time, and is replaced by a younger one which has been developing behind it. The tail-spine is used as a weapon of defence, and severe lacerated wounds can be inflicted by it. Similar spines are present in some of the Eagle Rays (family

Sting Rays. Myliobatidæ, Wall-case 3; see 125). The Sting Rays are mainly inhabitants of tropical waters, but one species, *Trygon pastinaca*, 134, occurs off the British coast. Some of the American

species are inhabitants of fresh water. The large specimen (130) in the middle of the case is *Trygon sephen*, from India; near it are shown the tail-spine of *Trygon walga* (132), also from India, and the jaws of *Trygon thalassia* (131). Hanging from the side

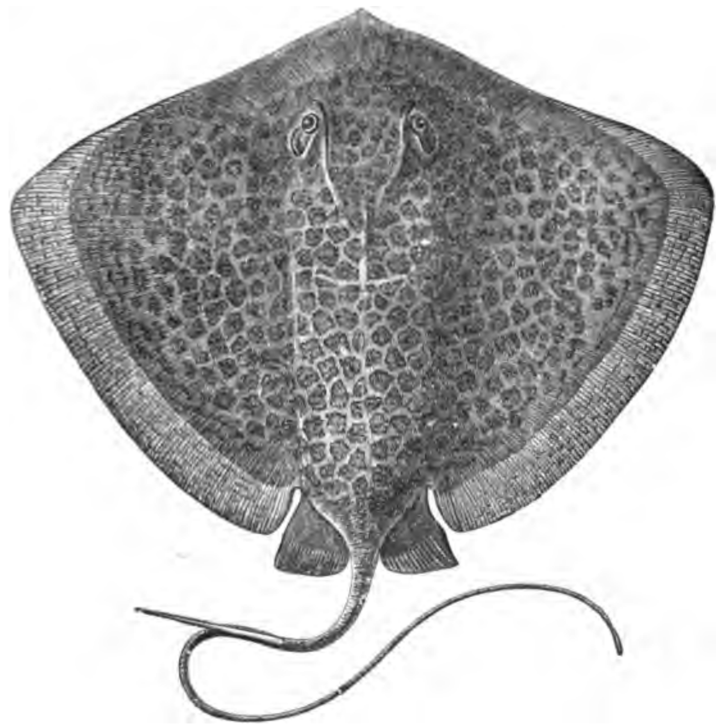

FIG. 25.—A Sting Ray, *Trygon uarnak.*

rail at the other end of the Gallery, opposite Wall-cases 13 and 14, are two other Sting Rays, *Trygon brevicaudata* and *Trygon tuberculata*. Belonging also to the family are *Urogymnus asperrimus*, 135, with densely crowded calcareous tubercles in the middle of the back, *Tæniura lymma*, 137, with a row of spines along] the middle of the back, and the Butterfly Ray, *Pteroplatea micrura*, 138, with a disc twice as broad as long, and with a short, thin tail.

The Trygonidæ do not lay eggs as do the Skates; the young complete their early development within the body of the mother,

Fig. 26.—A Pleuracanthodian Shark, *Pleuracanthus decheni*, restored. (After A. Fritsch, slightly altered.)

absorbing nourishment from the numerous filaments or 'trophonemata' which project inward from the oviducal wall (see *Trygon bleekeri*, 133, and *Pteroplatea micrura*, 136 A and B). A somewhat similar provision for nourishing the young occurs in the Piked Dog-fish and the Smooth Hound, in which the trophonemata are represented by semicircular lappets of the lining of the uterus, each with a blood-vessel passing round the free edge.

PLEURACANTHODES (Pleuracanthodian Sharks).

The order Pleuracanthodes includes Palæozoic Sharks of primitive type (fig. 26), the remains of which occur in rocks ranging from the Lower Carboniferous to the Lower Permian. The cartilages are permeated with minute granular calcifications, and the cranium sometimes possesses a curious symmetrical fissuring, although there are no true membrane bones. Slight calcifications sometimes occur in the sheath of the notochord. The paired fins have a long segmented axis of cartilage, fringed on one or on both sides with cartilaginous fin-rays, to the extremities of which the dermal fin-rays are attached in bunches (see sketch 141). The median fins are extensive. There is no shagreen, but small scattered tubercles occur in the skin, and there is a median spine projecting from the back of the head.

Pleuracanthus.

The restored sketch (natural size) of *Pleuracanthus decheni*, 140, from the Permian Beds of Bohemia, shows the principal characters of these Sharks; the mouth is nearly terminal (fig. 26), the tail tapers evenly and symmetrically, the upper part of the caudal fin is separated by a short break from the dorsal fin, which extends forward nearly to the head, and there are two small anal fins. Remains of other species of *Pleuracanthus* occur in the Coal Measures of France, England, and America. The teeth (see sketch 142) are tricuspid, but the middle denticle being comparatively minute the name *Diplodus* is commonly applied to isolated eeth of the genus.

HOLOCEPHALI (Chimæroid Fishes).

Wall-case 5.

The Chimæroid fishes are fishes of grotesque appearance, occurring mostly in deep water, and related most nearly to the Elasmobranch fishes (Sharks and Rays), although their dentition

bears some resemblance to that of the Dipnoan fishes (Lung-fishes), consisting of three pairs of tooth-plates (see 151), and the upper jaw is confluent with the cranium, as in the Dipnoi (see skull 148; also 154). The skin is soft and except in the extinct genera has few dermal denticles. The skeleton is cartilaginous, the notochord is persistent, and the calcified rings that occur in its sheath are more numerous than the vertebral segments. The marginal parts of the fins are supported by sheets of closely-set

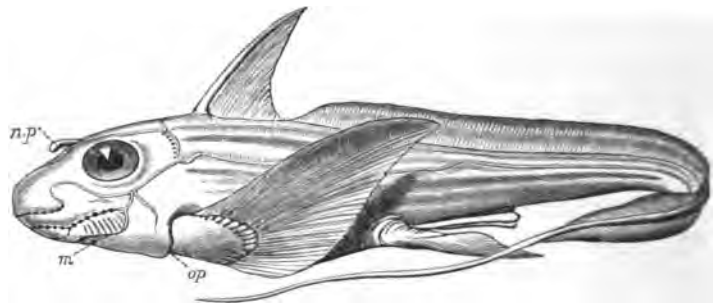

FIG. 27.—Rabbit-fish, *Chimæra monstrosa*.
m., mouth; *n.p.*, nasal process, occurring in male only; *op.*, operculum or gill-cover. (After Bridge, Camb. Nat. Hist., vii, 1904.)

horny fin-rays. A spine is present in front of the first dorsal fin. The tail is long and terminates in a filament. The gill-slits do not open separately on the sides of the neck as they do in the Elasmobranchii, but are crowded together beneath a gill-cover (operculum), which is not supported by skeletal parts as it is in bony fishes like the Cod and Mackerel. Spiracles are wanting in the adult. There are valves in the conus arteriosus of the heart, and a spiral valve in the intestine. The intestine opens separately on to the exterior, and not into a common cloaca as it does in the Elasmobranchii. The eggs are large and the egg-shells horny (see 153). In addition to the pelvic claspers, such as occur also in Elasmobranch fishes, the male Chimæroids have a pair of anterior claspers and a curious process arising from the snout (fig. 27, *n.p.*). The subclass is an ancient one; dental plates recognisable as those of Holocephali, and dorsal fin-spines (ichthyodorulites) are found in rocks of Devonian age.

Squaloraia (145) is an extinct Chimæroid, the remains of which occur in the Lower Lias of Lyme Regis. The dentition is simpler than that of the recent Holocephali, and the plates are much thinner.

Rabbit-fish.

In *Chimæra* (149, and fig. 27) the snout is bluntly conical, and

the mouth is small and situated on the under side of the head. The pectoral fins are large and set low down. The first dorsal fin stands high and is almost continuous with the long second dorsal, which itself is barely separated from the upper part of the tail fin. There is a small anal fin separated by a short interval only from the caudal. The caudal fin-membrane is about as high above as below the axial part of the tail. *Chimæra monstrosa,* the Rabbit-fish, 149, occurs in the Mediterranean and off the west coast of Europe and Africa; it is caught as far north as the Orkney Isles. The American Elephant-fish or Spook-fish, *Chimæra colliei,* occurs in the Pacific Ocean only and is found in less deep water than the other Chimæroids. *Chimæra phantasma* is a Japanese species.

Elephant-fish.

The Southern Elephant-fish, *Callorhynchus antarcticus,* 147, is distinguished by a remarkable cutaneous flap depending from the extremity of the rostrum. The tail is more distinctly heterocercal than in *Chimæra,* and the second dorsal fin is more widely separated from the first. A skeleton of *Callorhynchus* is shown on the floor of the case (146). *Harriotta,* 157, is a fish which grows to about two feet in length; it has an elongated rostrum, large pectoral fins, and the anal fin not separated from the caudal. *Harriotta* occurs in about 1,000 fathoms in the West Atlantic, and was first described in 1894.

The Chimæroid fishes attained their greatest development, both as regards number of genera and the size of the body, in the Cretaceous and Eocene periods. Comparison of the tooth of *Edaphodon sedgwicki* exhibited (155) with that of *Callorhynchus* (148) and *Chimæra* (151) shows how much greater was *Edaphodon* than the modern representatives of the Holocephali.

OSTRACODERMI (Ostracoderm Fishes).

The Ostracodermi are extinct fishes, the remains of which occur in Upper Silurian and Devonian strata. The head region is large and broad; calcified scales occur on the tail, and protective shields on the front part of the body. Grooves on the surface of the plates and shields indicate a well-developed system of dermal sense-organs (lateral-line organs). The notochord was persistent, and there were no differentiated vertebræ. Definite jaws seem to have been wanting, and on account of this feature the Ostracodermi are by some authorities associated with the Cyclostomi

(Lampreys and Hag-fishes). They were probably bottom-feeders and of sluggish habits. The models exhibited were constructed mainly from descriptions and figures in "The Fishes of the Old Red Sandstone," (Palæont. Soc.), by E. Ray Lankester, 1868,

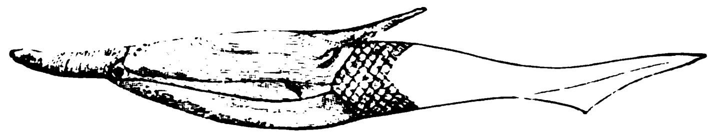

FIG. 28.—Restoration of *Pteraspis rostrata*, side view. (After A. S. Woodward.)

and R. H. Traquair, 1894, 1902, 1904, and from the Geol. Mag., 1902 (Traquair), and from specimens in the Geological Department of the Museum.

Pteraspis. The first two specimens (160 and 161) show the upper and under surfaces of *Pteraspis rostrata*; the models are $2\frac{1}{2}$ times natural

FIG. 29.—Dorsal shield of *Pteraspis rostrata*, upper view. (After Lankester.)

size (linear enlargement). The hinder part of the tail is not shown, since nothing is known of its shape or length.

In *Pteraspis* (see figs. 28 and 29) the chief body plates are a conical plate in front, a large dorsal plate with a spine projecting from its hinder edge, a pair of long side plates, and a large ventral plate. The ventral plate was at first thought to belong to a different animal, and was named "*Scaphaspis*." The eye is small and lateral, and the exhalent aperture of the gill-chamber is

near the hind end of the lateral plate on each side. The covering of the front part of the tail consists of closely-set rhombic scales. Remains of *Pteraspis* occur in the Lower Old Red Sandstone of England and Scotland, and the Lower Devonian of Galicia.

Drepanaspis. The models of *Drepanaspis gemündenensis* (162 and 163; see also fig. 30) are of the natural size, and are based on the results of extensive investigations conducted by Dr. R. H. Traquair. The head and trunk region is broad, depressed, and sharply marked off from the tail, which is short, and terminates in a high caudal fin provided with stout marginal scales (fulcra) on its upper and lower edges. The median shields of the dorsal and ventral

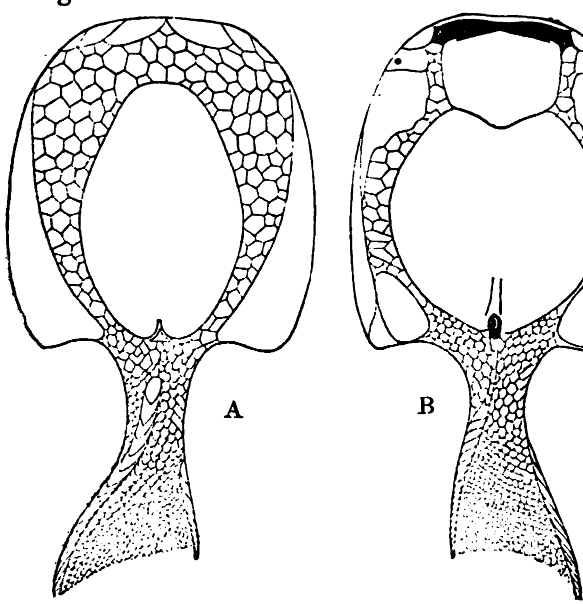

FIG. 30.—Restoration of *Drepanaspis gemündenensis*.
A, upper view; B, lower view. (After R. H. Traquair.)

surfaces are relatively smaller than in *Pteraspis*, and are bounded by a mosaic of small plates. The remains of *Drepanaspis* occur in the Lower Devonian rocks of Gemünden, in Germany.

Cephalaspis. The model of *Cephalaspis* (164) is enlarged three times (linear). In *Cephalaspis* the eyes are large and fairly close together; there is median dorsal fin and a heterocercal tail. The head-shield of *Cephalaspis* is large, rounded in front, and with a moderately sharp edge. The angles of the head-shield are produced backward,

and internally to these projections are movable flaps of elliptical shape above the gill-chambers. The scales on the side of the trunk region are high and narrow. Remains of *Cephalaspis* occur in the Lower Old Red Sandstone of Scotland and the Devonian of Canada.

Pterichthys. *Pterichthys* (fig. 31) is represented by a model of *Pterichthys milleri* (165) enlarged four diameters. In *Pterichthys* the head-plates are so grouped and so separated from the body-plates as to

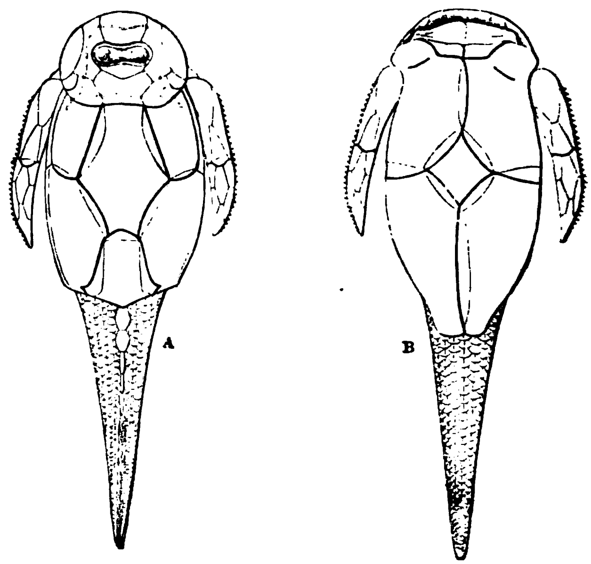

FIG. 31.—Restoration of *Pterichthys testudinarius*.
A, upper view; B, lower view.

suggest that the head was movable upon the body. The lateral line grooves are well marked; the eyes are close together. A pair of limbs articulate at the front of the body region and consist of a hollow skeleton of dermal plates, presumably filled in life by muscles, &c. There is a median dorsal fin; the tail is heterocercal and its sides are covered with imbricated scales. Remains of *Pterichthys* occur in the Lower Old Red Sandstone of Scotland and in the Devonian of the Eifel district. Visitors may be interested to know that a cardboard model of *Pterichthys* constructed by Hugh Miller is on exhibition in the Gallery of Fossil Fishes in the Geological Department of the Museum.

DIPNOI (Lung-fishes).

The Dipnoi are termed 'Lung-fishes' because the existing forms—*Ceratodus*, *Lepidosiren*, and *Protopterus*—have an air-bladder adapted for use as a lung, supplementing and in dry weather supplanting the gills as the organ of respiration. The air-bladder is further comparable with the lung of Amphibians, Reptiles, Birds and Mammals in that it returns the aërated blood direct to the heart, whereas in most fishes the blood from the air-bladder is carried through the general circulation before reaching the heart. Wall-case 6.

The body is covered with overlapping cycloid scales. The skeleton is largely cartilaginous. The skull consists of cartilage

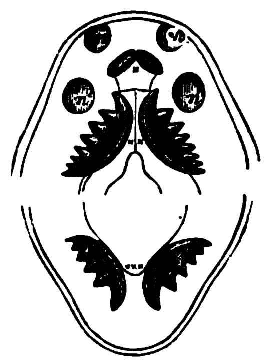

FIG. 32.—Mouth of *Ceratodus forsteri*, widely open to show the nostrils and teeth. *n* and *n'*, narial openings; *x*, vomerine teeth; *xx*, palato-pterygoid teeth; *xxx*, mandibular teeth.

covered by membrane bones, *i. e.* bones which are superficial, developed in the membrane covering the cartilage and not formed by the deposition of salts of lime in the cartilage itself. There are no distinctly differentiated maxillary and premaxillary bones (the bones which form the upper jaw in man), and the functional upper jaw (palato-quadrate cartilage) is confluent with the cranium, a condition designated by the expression 'autostylic skull,' a condition also met with in the Chimæras (Wall-case 5). The teeth are few, usually three pairs (fig. 32), and

similar to those of the Chimæras, namely a pair of mandibular plates below, and a pair of large palatine plates and a pair of small vomerines above. They are tuberculated, as though made up of fused denticles.

The notochord is persistent, with unsegmented sheath and without vertebral centra. The vertebral axis of the tail is uptilted in most of the ancient forms, but the tail has a straight axis and a tapering, symmetrical outline in the recent forms. The paired fins are long and pointed, and each has a central, muscular, scale-covered lobe, and a fringe or marginal membrane supported by closely-set dermal fin-rays.

The gills are covered by a movable operculum or gill-cover, devoid of branchiostegal rays. The nasal sacs open into the mouth (fig. 32, p. 55) as well as on to the exterior of the snout, a condition met with in Amphibia and higher Vertebrates, but very uncommon in fishes. The conus arteriosus of the heart is spirally twisted, and is provided with several longitudinal rows of valves. The other chambers of the heart are partially divided into right and left parts, the left part carrying the blood from the air-bladder or lung-sac. In the intestine is a spiral valve, and the intestine and the urinary and genital ducts open into a common cloaca. The roof of the mid-brain is not divided into right and left optic lobes, and the optic nerves meet below the brain in the form of a cross or "chiasma."

CTENODIPTERINI.

The Ctenodipterini are extinct Dipnoi of the Devonian, Carboniferous, and Permian epochs. The skull has numerous roof-bones; the bones of the gill-cover are less reduced, and the body-scales are thicker than in the living Dipnoi. The principal families are the Ctenodontidæ, Dipteridæ, and Phaneropleuridæ, represented respectively in Wall-case 6 by a tooth-plate of *Ctenodus* (170),
Dipterus. and restored models of the complete fish of *Dipterus* (168, and fig. 33) and *Phaneropleuron* (169, and fig. 33). In the Dipteridæ the vertebral axis of the tail is uptilted (heterocercal tail), while in

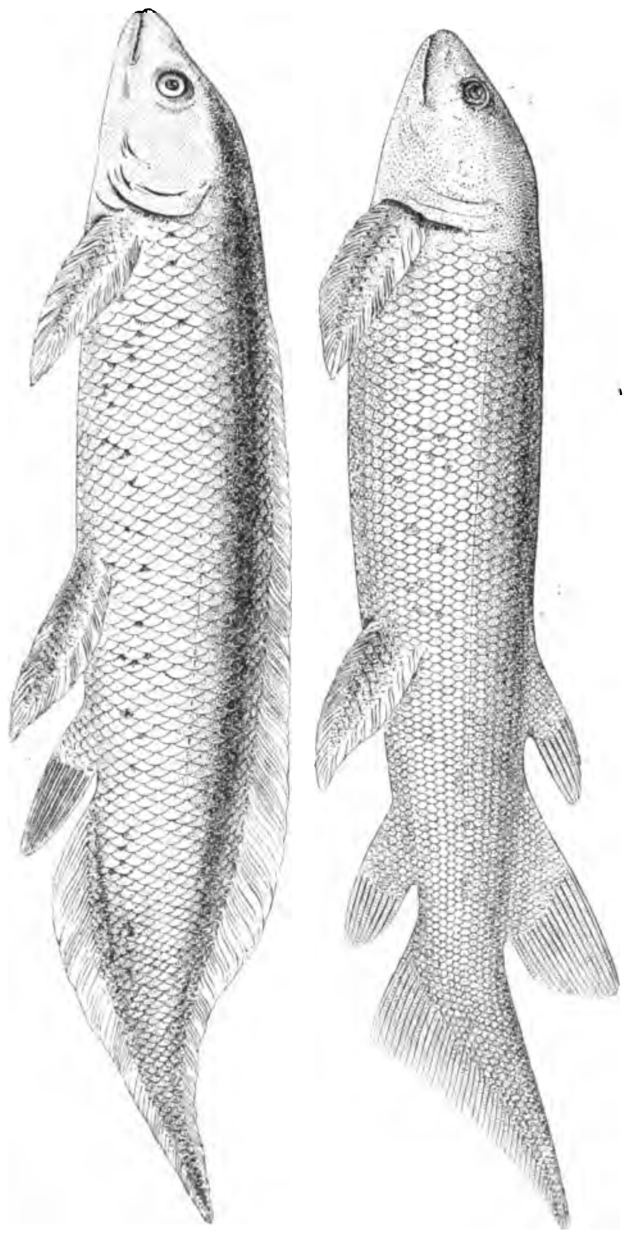

FIG. 33.—Two extinct Lung-fishes, restored; *Dipterus valenciennesi* (upper figure) and *Phaneropleuron andersoni* (lower figure).

the other two families the vertebral axis is straight and the outline of the tail symmetrical (diphycercal tail). A distinct anal fin is present in the Phaneropleuridæ and Dipteridæ, and two separate dorsal fins in the latter family.

MONOPNEUMONES.

Cerat-odus.

In the Monopneumones the lung, or modified air-bladder, is a single organ; it lies to the dorsal side of the alimentary canal, but opens into the ventral wall of the œsophagus. It has a central cavity, communicating with air-cells or alveoli in the thickness of its walls. The Ceratodus or Australian Lung-fish, *Ceratodus forsteri* (171, and fig. 34), which is the sole living representative of the order, lives in the stagnant pools connected with the Burnett and Mary Rivers of Queensland. It is sluggish in habit and feeds on crustaceans, worms and molluscs. It has four pairs of well-developed gills by which aquatic respiration is effected. In the dry season, when the water is thick and foul, and to a less extent at other seasons also, the fish rises occasionally to the surface to empty its lung-sac and to take a fresh supply of air. The Ceratodus grows to a length of five or six feet, and is excellent eating. It was first described in 1870 by Mr. G. Krefft, who recognised the teeth as similar to the teeth of *Ceratodus* which had long been known in a fossil state from the Jurassic rocks. The name 'Barramunda' is sometimes applied to *Ceratodus*, but it is used indiscriminately by the aborigines for any large fresh-water fish, and as often as not is applied to *Osteoglossum* (*Scleropages*) *leichardti*.

The paired fins of the Ceratodus are long and pointed, and each consists of a middle, thick, muscular part or 'lobe', supported by an axial series of cartilages, and two series of obliquely disposed, smaller cartilages in connection with the former, and a fringe or fin-membrane supported by numerous closely-set fin-rays of dermal origin. This type of fin is known as the 'archipterygium', and was formerly regarded as a primitive type of fin. The tail is reduced and symmetrical, and is continuous with the single dorsal and anal fins. The cartilage of the skull is protected by a few large bony plates, covered with skin.

FIG. 34.—Australian Lung-fish *Ceratodus forsteri*.
(From Bridge, Camb. Nat. Hist., vii, 1904, after Günther.)

DIPNEUMONES.

Proto-pterus. In the Dipneumones, including the African Lung-fishes, *Protopterus*, 174, 175, 176, and the American Lung-fish, *Lepidosiren*, 173, the lungs are two in number, but they communicate with the œsophagus by a single opening. The gill system is more reduced than in *Ceratodus*, for whereas in that fish four gill-arches bear gills, in the Dipneumones the first and second arches have no gills. In the young there are one or more external gills, projecting freely, and situated above the gill-opening. These have a thick central axis and a fringe, and bear some resemblance to the fins, so much so that some authorities regard the paired limbs of Vertebrates as having been derived by a modification of gill structures. Occasionally the external gills persist, in a reduced form, in adult life. As in *Ceratodus* the tail is reduced and symmetrical, and is continuous with the single, undivided dorsal and anal fins, but the paired fins differ in being more slender and in not possessing the fringe along the front edge.

The genus *Protopterus* has a wide distribution over the continent of Africa, and three species are to be distinguished. The fishes are found in marshes in the vicinity of rivers; they are mainly carnivorous and voracious, and their food consists of frogs, worms and insects. The three species differ in the length of the head, the number of scales in the lateral line, the size of the eyes, and the position of the front end of the dorsal fin. The Gambian Lung-fish, *Protopterus annectens*, 176, has been longest known, the larger species, the Egyptian Lung-fish, *Protopterus æthiopicus*, 175, and the Congo Lung-fish, *Protopterus dolloi*, 174, are comparatively recent discoveries (fig. 35).

At the beginning of the dry season the Protopterus buries itself in the thick mud of the swamps in which it lives, and remains curled up in a dormant condition for several months. An opening is left at the upper end of the mud chamber for breathing purposes, respiration during the dry season being effected by the lungs alone. The two dried nodules of clay exhibited (178) contain each a small specimen (now shrivelled up) of *Protopterus annectens*.

Lepido-siren. In the South American Lung-fish, *Lepidosiren paradoxa* (173, and fig. 35), the body is long and rounded, and the paired fins

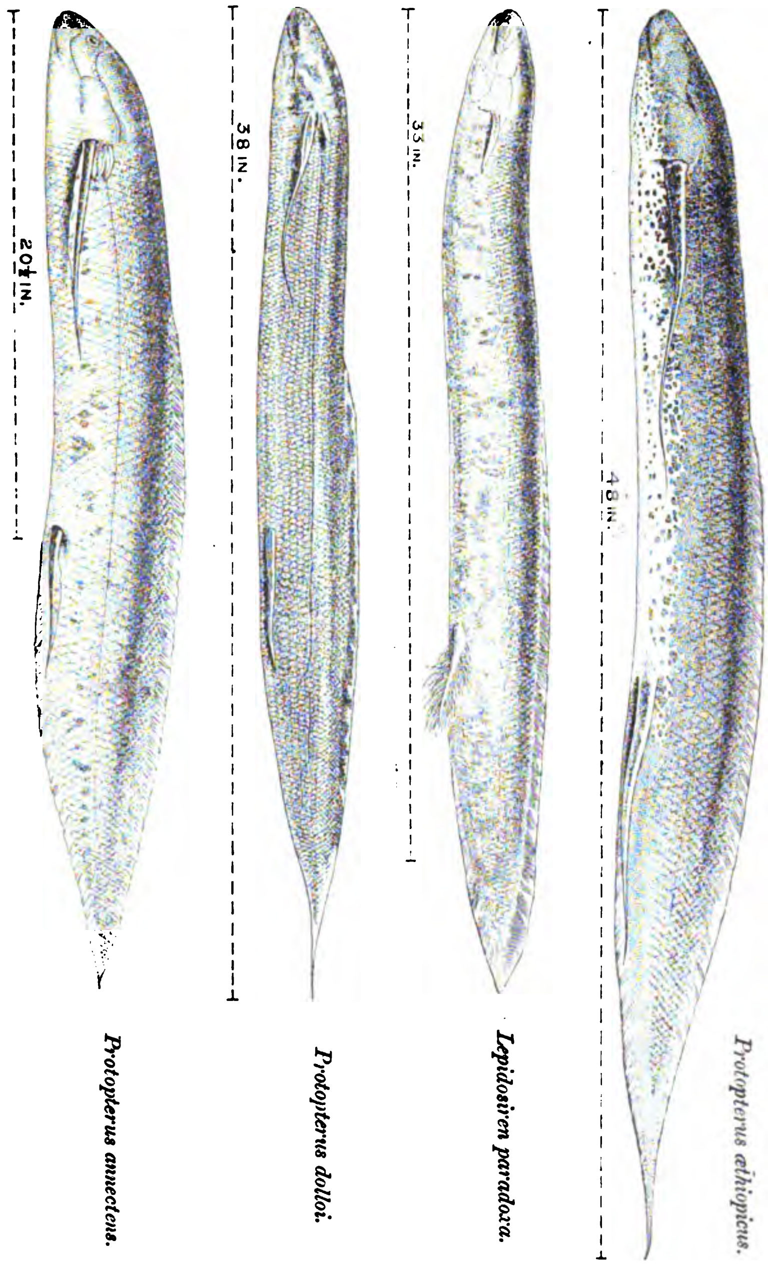

FIG. 35.—Lung-fishes. (The fishes are not drawn to the same scale of reduction; the proportional sizes of the four are indicated by the dotted lines, and by the lengths of the fishes in inches written against those lines.)

are so attenuated as to have the form of tapering filaments, devoid of scales and fin-rays. The red structures projecting as tufts from the pelvic fins are highly vascular filaments which are developed in the male during the breeding season, and doubtless act as accessory respiratory organs; they dwindle away after the breeding season. These accessory breathing organs are not altogether without parallel, for in a Siluroid fish, *Plotosus*, there is a median, red, tree-like, branched organ, situated immediately behind the anus and in advance of the anal fin. It is not clear in the case of *Plotosus* whether the organ varies in size at different seasons and whether it occurs in both sexes.

The Lepidosiren occurs in the marshes and swamps of the rivers of the central part of the South American continent. It is of sluggish habits and feeds on water-snails and water-weed. It rises to the surface to breathe, making use of the lung-sacs as well as the gills; in the dry season it remains in a torpid condition in the dried mud and breathes by the lungs alone. The flesh is much esteemed as food by the Indians. A series of the eggs and young of *Lepidosiren*, as also those of *Protopterus* and *Ceratodus*, are exhibited in Cabinet-case 29 (specimens 1159, 1160, 1161).

COCCOSTEOMORPHI (Jointed-neck Fishes).

Coccosteus.

The Coccosteus-like fishes (Coccosteomorphi or Arthrodira) are extinct fishes of the Devonian and Lower Carboniferous periods, and are but doubtfully referred to the subclass Dipnoi. The head and front portion of the trunk are covered with large bony plates, the head plates being movably articulated upon those of the body, whence the name Arthrodira (joint-neck). The teeth are somewhat similar to those of *Protopterus*. The vertebral axis appears to have been unossified, but the dorsal and ventral arches and the supports of the single dorsal fin are slightly bony. The tail is heterocercal, and there are evidences of the existence of pelvic fins. A restoration of *Coccosteus decipiens*, of the Lower Old Red Sandstone of North Scotland, is shown in two views, dorsal (180) and

side (181). Some of the North American forms of Arthrodiran fishes, such as *Gorgonichthys*, *Dinichthys*, and *Titanichthys*, were of enormous size, some idea of which may be gathered by a comparison of the mandible or lower jaw of *Coccosteus* (182) with that of *Gorgonichthys* (183).

TELEOSTOMI (Fishes with a Maxillary Upper Jaw).

In the Teleostome fishes the lower jaw or mandible is the same morphological element of the skull (namely, Meckel's cartilage and related bones) as in the previous subclasses of fishes, but the upper jaw, which bears usually one or more rows of teeth biting against the mandibular teeth, is not the palatoquadrate cartilage, but consists of bones of dermal origin called premaxilla and maxilla. The upper jaw of the Teleostomi is the equivalent of the upper jaw of the higher vertebrates, namely, Amphibians, Reptiles, Birds and Mammals. The palatoquadrate cartilages are present in the roof of the mouth, but they are reduced, and are of less importance than in the first four subclasses of fishes. Wall-case 6.

The gills are pectinate, the gill-filaments being arranged like the teeth of a comb, and they are protected by a gill-cover supported by opercular bones and (usually) branchiostegal rays, slender curved bones supporting the lower portion of the gill-cover. The skull is hyostylic, *i. e.* the jaw apparatus is linked to the auditory region of the skull by means of the hyomandibular bone. There is no cloaca and the rectum opens in front of the urinary and generative aperture or apertures. The ova are usually small and numerous.

STYLOPTERYGII (Fishes with Lobed Fins).

The Teleostome fishes are divided into three orders, the first two of which differ the one from the other chiefly in the characters of the paired fins. In the first order, the Stylopterygii, including the Crossopterygian Ganoids of older writers, the pectoral, and to a somewhat less extent the pelvic fins are 'lobed' like those of the

Dipnoi; they consist of a thick, muscular, scale-covered middle part, the lobe, either pointed or rounded at the end, and a fringe or marginal membrane supported by closely-set fin-rays developed in the skin (dermal fin-rays). The dorsal fins are two, or else (e. g. *Polypterus*, 193, and fig. 40) consist of numerous finlets; the pelvic fins are set well behind the pectorals (abdominal position).

The cartilage of the skull in the Stylopterygian fishes is well protected by dermal bones; there is no supraoccipital bone. There are two or more jugular plates between the halves of the mandible, and the branchiostegal rays have the form of lateral jugular plates. There are a pair of infraclavicles in the shoulder girdle. The known range of these fishes is from the Devonian epoch to the present time. In the sole living representatives of the order, *Polypterus* and *Calamichthys*, the heart has a conus arteriosus provided with numerous valves; there is a spiral valve in the intestine, the spiracles are open, abdominal pores are present, the air-bladder has an open duct, and the optic nerves meet below the brain in the form of a cross, or 'chiasma.' The principal suborders of the Stylopterygii are the Holoptychioides or Rhipidistia, the Cœlacanthoides or Actinistia, and the Polyteroides or Cladistia.

HOLOPTYCHIOIDES.

The Holoptychioides are extinct fishes, the remains of which occur mostly in rocks of Devonian and Carboniferous age. In the anal fin and in each of the two dorsal fins the most internal skeletal elements (axonosts) are fused into a single piece, with a broad outer bend, bearing from three to six rod-like elements (baseosts), which are fewer than the dermal fin-rays, and are overlapped by them. The skeleton of the pectoral fin articulates with the shoulder girdle by a single basal element (unibasal fin). The vertebral column has no ossified centra, or has ring-like centra. The teeth have a complicated folded structure; the nostrils are on the lower surface of the snout.

In the family Holoptychiidæ, e. g. *Holoptychius flemingi* (186, and fig. 36), the remains of which fish occur in the Upper Old Red Sandstone of Scotland and the Upper Devonian of Belgium, the body is covered with overlapping cycloid Holoptychius.

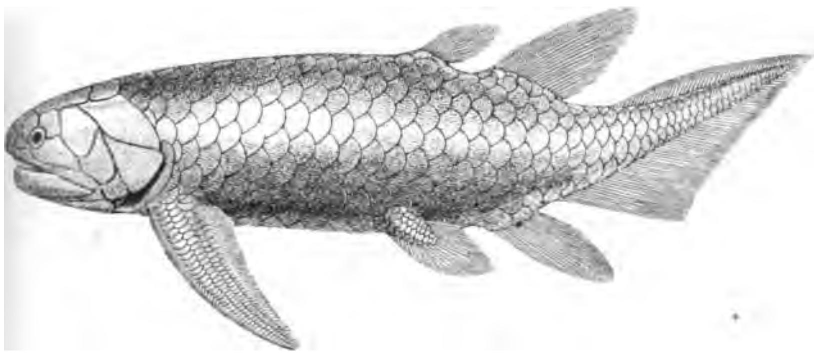

FIG. 36.—*Holoptychius flemingi*, restored.

scales with a superficial layer of hard substance resembling the enamel of teeth, and called vitro-dentine or ganoin. The pectoral fins have a long, pointed, scaled a xis or lobe, the vertebral column has no bony centra, the axis of the tail is slightly uptilted, and the vertical infoldings of the teeth are very numerous and complex.

In the family Rhizodontidæ, represented in the exhibited series by *Eusthenopteron foordi* (188, and fig. 37), a fish found in the Upper Devonian of Canada, the scales are cycloid, like those of *Holoptychius*, the pectoral and pelvic fins are shorter than those of the Holoptychian fishes, the vertebral column has ring-like centra in some of the genera, the axis of the tail is either straight or is slightly uptilted, the teeth are conical, and the vertical infoldings of the walls are comparatively simple.

Resembling the Rhizodontidæ in the pectoral fins being obtusely lobate, but differing in the scales being rhomboidal instead of

Fig. 37.—*Eusthenopteron foordi*, restored.

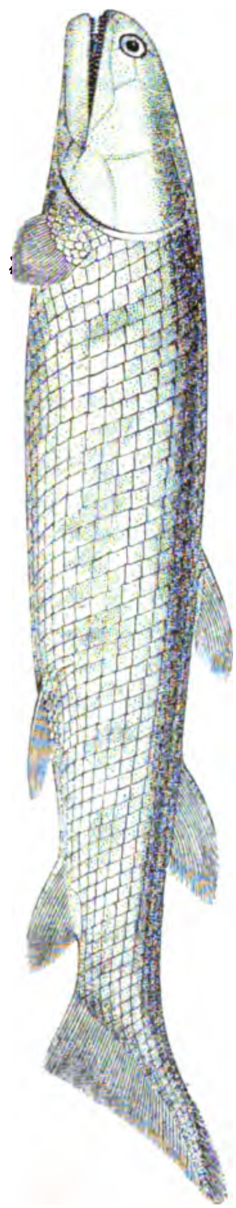

Fig. 38.—*Osteolepis macrolepidotus*, restored.

cycloid, and in having a more continuous and smooth layer of ganoin, are the Osteolepidæ, e. g. *Osteolepis macrolepidotus* (189, and fig. 38), a fish whose remains occur in the Lower Old Red Sandstone of Scotland, and *Megalichthys hibberti*, 190, a much larger fish from the Coal Measures of Great Britain. The vertebral column has ring-like centra in the caudal region; the vertebral axis of the tail is slightly uptilted, the teeth are conical, with the wall only slightly infolded at the base. **Osteolepis.**

The four restorations alluded to in the preceding paragraphs, and several others exhibited in Wall-cases 5–7, have been constructed after critical examination of the remains of the fishes in the Geological Department of the Museum, and the published figures of other specimens, with a view to enabling the public visiting this Gallery to form some idea of what the fishes probably looked like in the ages long ago in which they lived. The size of the fish, the form of the body, whether rounded or flattened, the shape of the various fins, their positions on the body, the outline of the tail, the characters and arrangement of the scales and head-plates—these are details which may be gathered from the

restorations. The colours that have been given to the models are, of course, fanciful; the plaster models in their natural whiteness would have been painful to the eye, and although to leave them uncoloured would have been a more candid admission of ignorance as to what the real colours of the fishes were, the models would not have lent themselves well for comparison of their structural features with those of the stuffed fishes exhibited in the same cases.

CŒLACANTHOIDES.

The suborder Cœlacanthoides is represented by a restoration of *Undina gulo* (192, and fig. 39) from the Lower Lias of Dorset, and a cast of a specimen of *Undina penicillata,* 191, from the Lithographic Stone (Lower Kimmeridgian) of Bavaria. The range of the suborder in the present state of our knowledge is from the Lower Carboniferous to the Upper Cretaceous. The proximal skeletal elements, or axonosts, of the anal fin and of each of the dorsal fins are fused into a single piece. The paired fins are comparatively short (obtusely lobate), and the skeleton of the pectoral is unibasal. The vertebral column is without bony centra. In the tail fin above and below the vertebral axis the axonosts are equal in number to the neural and hæmal spines of the vertebræ, and each axonost is directly connected with a single dermal fin-ray. The outline of the tail is symmetrical, usually with an axial vestige of the dwindling caudal fin proper, showing that the "tail fin" is composed mainly of detached portions of the dorsal and anal fins. The distal parts of the dermal fin-rays of all the fins are transversely jointed, but they are not forked. The scales are cycloid, and the teeth are simple. The skeleton of the gill-cover is reduced to a single opercular bone. There is a bony wall to the air-bladder. The nostrils are on the under side of the snout. The principal genera are *Cœlacanthus* (Carboniferous and Permian of Britain and Germany), *Undina* (Jurassic), *Diplurus* (Trias of North America), and *Macropoma* (Cretaceous of England, &c.).

Undina.

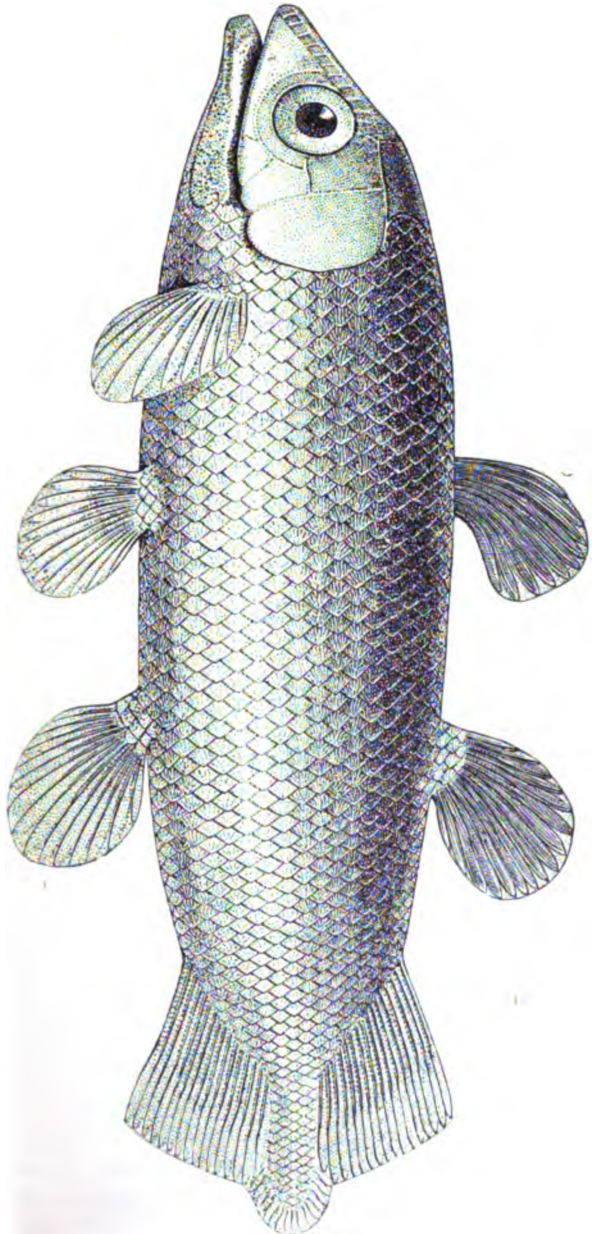

FIG. 39.—*Undina gulo*, restored.

POLYPTEROIDES.

Polypterus. The suborder Polypteroides includes the only modern Crossopterygian fishes, namely *Polypterus* (193, and fig. 40), and *Calamichthys* (195), fresh-water fishes of tropical Africa. The dorsal fin has the form of numerous finlets, each with a spine in front; the outline of the tail is symmetrical, and the axis is not uptilted in the adult, although it is in the young. The pectoral fins are obtusely lobate; the skeleton of each consists of three basal elements articulating with the shoulder girdle, a row of rod-like bones radiating from their periphery, and long, thin, closely-set dermal fin-rays supporting the marginal fringe of the fin; the pelvic fins are not lobate. The centra of the vertebræ are ossified, and are concave in front and behind (amphicœlous). The scales are rhombic, set in oblique lines, thick, with an external layer of smooth, hard vitro-dentine or ganoin, covered by soft skin. The teeth are simple, the walls not folded. There are two vomerine bones, and two jugular plates. The nostrils are on the upper side of the snout and project as short tubes; the spiracles remain open.

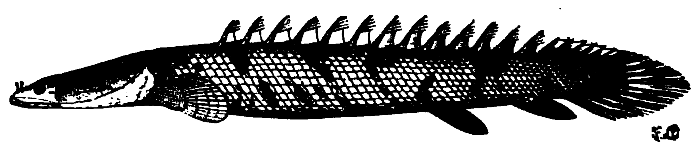

FIG. 40.—*Polypterus bichir.*

Polypterus (193), like the Lung-fishes, is capable of breathing air, but it cannot remain alive out of water more than three hours. The air-bladder is double and cellular, and its duct opens into the ventral wall of the pharynx. Its blood-supply is from the efferent vessel of the last gill; its vein joins the hepatic vein, and does not carry the blood direct to the heart as it does in the Dipnoi. The young *Polypterus* has an external gill, which is attached to the operculum (fig. 41). Ten or more species of *Polypterus* are known; the earliest known species is *Polypterus bichir* of the Nile, which is said to attain a length of four feet. It feeds on small fishes, frogs, and crustaceans. *Calamichthys* (195), is a

smaller and more attenuated and eel-like fish than *Polypterus*; it has no pelvic fins, and the dorsal finlets are more isolated, and each spine supports but a single soft ray. The fish lives in shallow parts of the Senegal and Congo among the interlaced roots of palms.

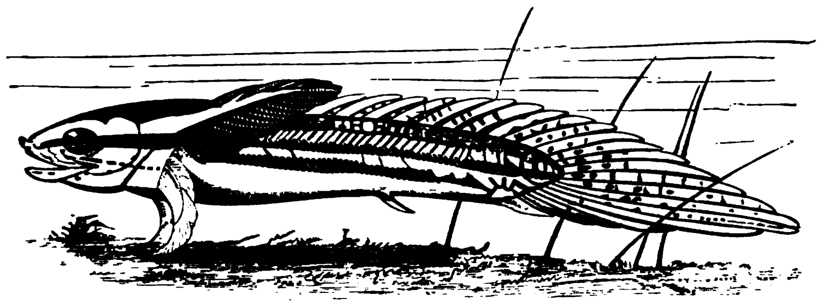

FIG. 41.—Larva of *Polypterus senegalensis*, × 4, showing the large external gill. (From Bridge, Camb. Nat. Hist., vii, 1904, after Budgett.)

ASTYLOPTERYGII (Ganoid Fishes without Lobed Fins).

In the Astylopterygii the paired fins have not a conspicuous muscular "lobe." The projecting part of the fin consists of skin supported by large bony fin-rays of dermal origin, which articulate at their bases with a row of cartilages or bones, called the pterygia, embedded in the body and connected with the shoulder girdle (see skeleton of pectoral fin of Sturgeon, 209, and of Gar-pike, 217). The pelvic fins are set far behind the pectorals (abdominal position); the skull is well protected by dermal bones; there is no supraoccipital bone. The known range of these fishes is from the Devonian epoch to the present time. In the living representatives, *e.g.* the Sturgeon, Gar-pike and Bow-fin, the heart has a conus arteriosus provided with two or more rows of valves; there is a spiral valve in the intestine; abdominal pores are present; the air-bladder has an open duct; the testis is connected with the kidney; and the optic nerves meet below the brain in the form of a chiasma. There are three suborders, the Sturioniformes or Sturgeons, the Lepidosteiformes or Gar-pikes, and the Amiiformes or Bow-fins.

Sturioniformes (Sturgeons).

Tde Sturioniformes or Chondrostei are the fishes long known as the "Cartilaginous Ganoids." In the most ancient forms (e. g. *Palæoniscus,* 196, and fig. 42) the covering of the body consists of a continuous cuirass of rhombic scales, rarely of cycloid scales. In the modern forms the skin is almost devoid of scales, as in

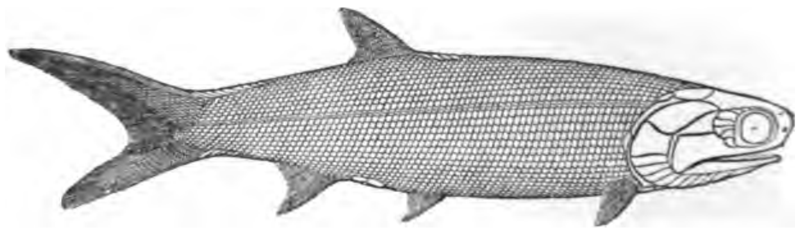

Fig. 42.—Restoration of *Palæoniscus macropomus.* (After R. H. Traquair.)

Polyodon, the Paddle-fish (211), or there are five longitudinal rows of keeled scutes, as in *Acipenser,* the Sturgeon (201). The endoskeleton is largely cartilaginous; the head is covered with bony plates of dermal origin; the notochord is persistent and not constricted by the formation of vertebral centra. There is a single dorsal fin and a single anal fin, with fulcra, *i. e.* spine-like scales along the front edge; the fin-rays of the median fins are more numerous than the basal elements; the caudal fin is usually heterocercal and with fulcra. The pelvic fins have a series of basal cartilages. An infraclavicle is present in the pectoral girdle, in addition to the clavicle and supraclavicle (see 208). The teeth are small or absent. The range of the suborder is from the Lower Devonian to the present time.

Palæoniscus. The Palæoniscidæ (196–197) are extinct fishes with elongate and fusiform body, with short-based dorsal and anal fins, and with a complete investment of rhombic scales, rarely with cycloid scales. The Palæoniscid fishes range from the Devonian to the Jurassic, and were most abundant in Carboniferous and Lower Permian times. *Cheirolepis* (197), is of Devonian age, and *Palæoniscus* (196) Upper Permian.

The Platysomatidæ (198) are extinct fishes ranging from the Carboniferous to the Permian. The body is laterally compressed and rather deep in a vertical direction, with a close investment of rhombic scales; the base of the dorsal fin is extended, the tail

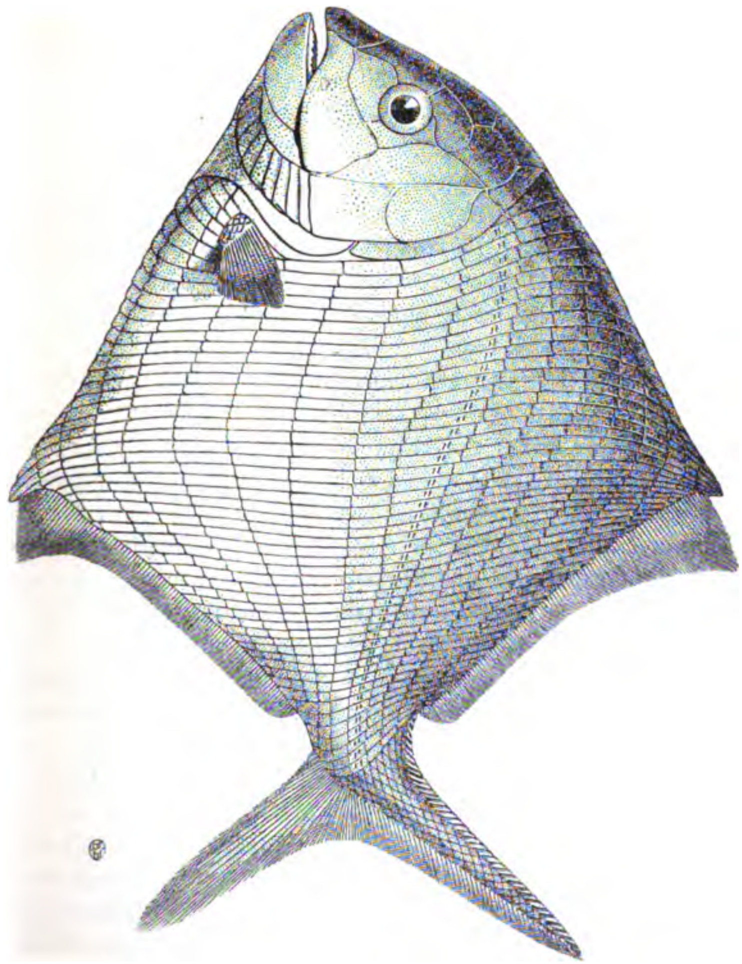

FIG. 43.—*Cheirodus granulosus*, restored.

heterocercal. As in the previous family there are broad branchiostegal rays, with an anterior median plate in front. The jaws are short and stout, the teeth obtuse. The principal genera are *Cheirodus* (198, and fig. 43), *Eurynotus*, and *Platysomus*. Cheirodus.

Chondrosteus. The Chondrosteidæ (e. g. 200), which may be regarded as a connecting link between the ancient Palæoniscidæ and the modern Sturgeons, include *Chondrosteus*, from the Lower Lias of England, and *Gyrosteus*, from the Upper Lias of Yorkshire. There are no scutes in the skin, but the dorsal lobe of the tail-fin is armed with fulcra and clothed with rhombic scales. The mouth is small, situated on the under side of the snout, and without teeth in the adult. The eye is set far forward; there are numerous branchiostegal rays.

In the Polyodontidæ, a modern family including the Paddle-fish of the Mississippi valley (211), and the Sword-bill Sturgeon of the rivers of China (212), the scales in the skin are very small and isolated; the tail is heterocercal, and is armed with fulcra on the upper edge, the snout is much prolonged, and without barbels. The mouth is large, with minute teeth; the bones of the cranial roof form a discontinuous shield; there are no spines to the pectoral fins.

Paddle-fish. The Paddle-fish or Spoon-bill Sturgeon, *Polyodon folium*, 211, is sluggish in its habits and feeds chiefly on the minute organisms contained in the mud which it consumes. The gill-rakers are long and fine, and form an efficient filter, preventing the food particles escaping through the gill-slits with the expiratory current of water. The paddle-shaped rostrum of the fish is used for stirring up the mud, and serves also as an organ of touch, necessary to the animal in consequence of the smallness of the eyes and the muddiness of the water which renders distinct vision impossible. The Paddle-fish reaches an occasional length of six feet and a weight of 120 lbs., but the average size is from 10 to 30 lbs. The

Sword-bill. Sword-bill Sturgeon, *Psephurus gladius*, 212, has a tapering rostrum, and the fulcra of the fins are fewer and of larger size than those of the Paddle-fish. The Sword-bill is said to attain a length of 20 feet; in its habits and mode of life it resembles the Paddle-fish.

In the Acipenseridæ, or Sturgeons proper, there are five longitudinal rows of keeled plates or scutes, and also small, irregular, stellate scutes scattered throughout the skin; the mouth is small, inferior, suctorial, and without teeth in the adult, and there are four barbels in front of the mouth. There are fulcra on the front

edge of the upper lobe of the tail fin, which is typically heterocercal. The first fin-ray of the pectoral fin is stout and spine-like. The gill-cover is supported by a single plate (opercular bone), and there are no branchiostegal rays. The bones of the cranial roof form a continuous shield, which has a median series of bones, not present in the Chondrosteidæ.

The fifteen or more species of Sturgeon (*Acipenser*) that are known occur in the seas, estuaries and rivers of the temperate and northern regions of the northern hemisphere. Most Sturgeons are migratory fishes, living in the sea, but ascending rivers for the purpose of spawning. Although the Sturgeons are not allied to the Salmons and are structurally very dissimilar, there is a strange parallelism in their habits and distribution; they are both anadromous, living in the sea but ascending rivers to spawn, and are both northern forms, common in Europe and North America, less common in Asia; in both there are some species or varieties which are non-migratory and confined to fresh water. Sturgeons are ground-feeders and rout about diligently in the gravel, sand and mud for the worms, small fishes, molluscs and crustaceans that constitute their food. The mouth is very protrusible, and is thrust downward as a spout-like tube into the mud. Sturgeon.

The Sturgeons are fishes of considerable economic importance. The flesh, though rich and fat, is esteemed as an article of food, and the ovaries of numerous Russian and American species find their way to market in the form of "caviare." The collection of the unshed spawn and its conversion into caviare form an important summer industry near the mouths of the great rivers of Eastern Europe. One of the most important stations is at Rubinsk, on the Volga, where the people collect in thousands in the late spring and await the advent of the fish in the river. As soon as notice is given by a look-out man of the arrival of the shoal, the people attack the fish by nets and spears. The ovaries are taken out, washed in vinegar, and spread upon boards in the open air. Salt is then rubbed in by hand and the caviare is pressed in bags and packed in kegs for the market. In Russia caviare is a regular article of diet, but in the western countries of Europe it is eaten only as a delicacy or a savoury. There is a superior form of caviare which is not salted and pressed, but is Caviare.

preserved on ice until it is required for consumption. From the air-bladder of the Sturgeon isinglass is prepared (see specimens 1185 in Cabinet-case 28). The air-bladders are slit open and cleaned and sent to market in the rough form, or the isinglass is extracted by hot water and dried in the form of thin sheets, which are sold as sheets, of various qualities, or are cut up into threads or rolled and bent into "staple." Specimens of all these kinds are shown.

Isinglass.

The great Russian Sturgeon, *Acipenser huso,* that furnishes so much of the caviare and isinglass of commerce, is not at the time of writing this guide-book on exhibition in the museum. It grows to a weight of 3,000 lbs., and is found in the Black Sea, Caspian Sea, Sea of Azov and their rivers. The Sturgeon that is found off the British coast is *Acipenser sturio,* a species that is also caught in the Black Sea, the Mediterranean, the seas of Western and Northern Europe, and on the Atlantic coast of North America. It grows to 10 or 11 feet. The specimen 1136 hanging from the rail opposite Wall-case 6 was caught on the Dogger Bank in 1873, and measures 10 feet 4 inches; that marked 1102, standing within the centre rail, measures a little over 8 feet.

Acipenser sturio is commonly called the Royal Sturgeon, specimens caught in British waters being the property of the sovereign, although the royal prerogative is not exercised. In parts of the Continent where it is common this Sturgeon (*Acipenser sturio*) is utilised as a source of caviare and isinglass, as also are the Short-snouted Sturgeon, *Acipenser güldenstädtii,* 201, of the Danube and rivers and seas of Russia and Western Asia, and the *Acipenser stellatus* of Russia, 204, so called from the star-shaped ossifications in the skin. *Acipenser naccarrii,* 205, is a Sturgeon confined to the Adriatic; it is known to the Italian fishermen as the "Storione cobice." *Acipenser maculosus,* 206, is the common Sturgeon of America; it is found on the coasts and in the rivers of Arctic and Eastern North America; *Acipenser rubicundus,* 202, is common in the great lakes of North America, and is called the Lake Sturgeon. The Sterlet, *Acipenser ruthenus,* 203, is a small Sturgeon, rarely exceeding three feet in length, found in the seas and rivers of Russia and also in the Danube; the flesh of the Sterlet is considered exceptionally choice.

The Shovel-nosed Sturgeon, *Scaphirhynchus platyrhynchus*, 210, of the Mississippi and other rivers of the Southern States of North America is confined to fresh water. It differs from the true Sturgeons of the genus *Acipenser* in the rostrum being long and flattened, in the absence of open spiracles, and in the union of the longitudinal rows of scutes beneath the dorsal fin to form a scaly armour investing the tail, whereas in the Sturgeons proper the rows of scutes remain distinct as far as the tail. Shovel-nose.

LEPIDOSTEIFORMES (Gar-pikes).

The Lepidosteiformes or Ætheospondyli are a small suborder including two families, the Aspidorhynchidæ and the Lepidosteidæ, the former with extinct fishes only. The body is covered with thick, rhombic scales, with a hard superficial layer of ganoin; they are arranged in oblique rows and are covered by a thin skin. All the fins have fulcra; the fin-rays are branched and jointed at their ends. The dorsal and anal fins are single and short-based, and their endoskeletal elements are as numerous as the dermal fin-rays. The pectoral fin has one row of basal bones (pterygia) carrying the dermal fin-rays *; the pelvic fins have not a series of basal cartilages. There is no infraclavicle in the pectoral girdle, and there is no pelvic girdle. The spiracle is wanting; the snout is elongated; in the mandible are splenial and coronoid bones; the vomerine bone is paired; there are no jugular plates; the opercular apparatus is complete; between the preopercular bone and the orbit are one or more rows of postorbital bones.

The Aspidorhynchidæ (213, and fig. 44, p. 78), are long-bodied fishes with a pointed preoral rostrum, and deep, rhomboidal, unequal scales. The fins are small, the fulcra weak; the caudal fin is homocercal, *i. e.* with symmetrical outline and without obvious uptilting of the vertebral axis. The vertebral centra are either

* The preparation marked 217 shows not merely the characters of the pectoral fin-skeleton of *Lepidosteus*, but may be taken to illustrate the distinctive features of the astylopterygian fin generally. The dermal fin-rays are strongly developed and form the most important part of the fin, while the basal parts of the skeleton, the pterygia, are reduced as compared with those of the stylopterygian fin, and are contained in a small muscular mound which projects but little from the side of the body.

ring-shaped or biconcave. The teeth are sharp; the lower jaw has a movable premandibular bone; the branchiostegal rays are numerous. These fishes range from the Lower Oolite to the Upper Chalk; there are two genera, *Aspidorhynchus* (213) and *Belonostomus*.

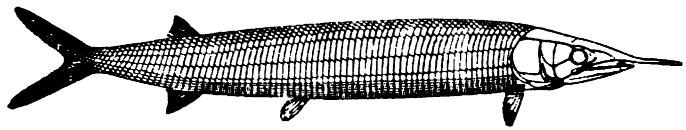

FIG. 44.—Restoration of *Aspidorhynchus acutirostris*. (After A. S. Woodward.)

In the family Lepidosteidæ the fin-fulcra are large; the tail has a fairly symmetrical outline although the vertebral axis is conspicuously uptilted; the centra of the vertebræ are well ossified and are convex in front and concave behind (opisthocœlous); the teeth are numerous, of unequal size, and the larger ones have the bases folded in a manner reminiscent of those of the Holoptychioides. The maxilla consists of several small bones in series; the branchiostegal rays are usually three. The conus arteriosus has eight longitudinal rows of valves, five in each row. Remains of species of *Lepidosteus* are known from Eocene and later strata.

Gar-pike. The existing species of *Lepidosteus*, known as Gar-pikes (214–216, and fig. 45), inhabit the fresh waters of North America

FIG. 45.—Broad-nosed Gar-Pike, *Lepidosteus viridis*.

and Cuba and one species occurs in China. The fishes are sluggish but voracious. They themselves are valueless as food, and they create havoc among other fresh-water fishes, against whose attacks they are invulnerable. Except in the breeding season the Gar-pike frequents the deeper parts of the rivers and lakes. The fish rises constantly to the surface, where it emits

bubbles of gas from the nostrils, situated near the end of the snout, in a manner suggesting that the air-bladder assists in the respiration.

AMIIFORMES (Bow-fins).

The Amiiformes or Protospondyli form a suborder of fishes all of which, except *Amia*, the Bow-fin of North America, are extinct, and most of which are Mesozoic in their stratigraphical range. The dermal fin-rays of the dorsal and anal fins are equal in number to the endoskeletal supporting elements; the endoskeletal elements of the pelvic fins are rudimentary or absent; there is no infraclavicle in the pectoral girdle. The extremity of the vertebral column is upturned, but the outline of the tail-fin is symmetrical. There is a median jugular plate between the halves of the mandible; the branchiostegal rays are flattened and rather broad; in the mandible are splenial and coronoid bones; there are two vomerine bones (coalescent in the Pycnodontidæ); there is no supraoccipital bone (except in *Dapedius*). The suborder comprises the families Semionotidæ, Macrosemiidæ, Pycnodontidæ, Eugnathidæ, Amiidæ, and Pachycormidæ. Wall-case 7.

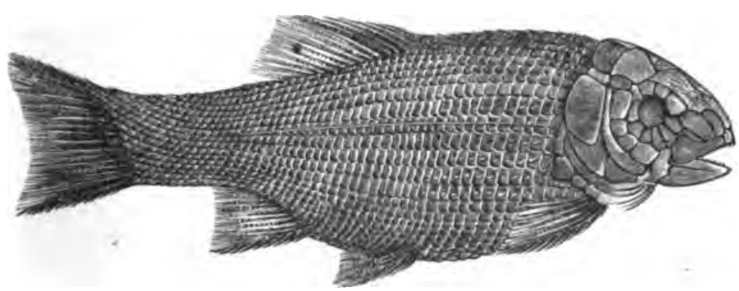

FIG. 46.—*Lepidotus mantelli.*

The Semionotidæ (fig. 46), the oldest and most generalised of the Amiiformes, are represented by *Lepidotus notopterus* (222), from the Lithographic Stone of Bavaria, the great *Lepidotus maximus* (1037, Table 49) from the same formation and locality, and a specimen of *Dapedius leiosomus* (223). In this family Lepidotus.

the body is somewhat compressed laterally and of moderate vertical depth, and is covered with rhombic scales; the dorsal fin does not extend more than half the length of the trunk; all the fins have large fulcra. The gape of the mouth is small, the jaws and vomer are provided with several rows of teeth, more or less conical. The vertebræ have either half-centra or ring-centra only, the notochord being evidently largely persistent in adult life. The parietal bones meet in the middle line. The range of the family is from the Upper Permian to the Cretaceous.

Pycnodontidæ. In the family Pycnodontidæ also the body is compressed, high and oval, with rhombic scales, which, however, are in some cases wanting in the hinder part of the body. The pelvic fins are small, the dorsal and anal fins are more or less extended, and the fin-rays robust; there are no fulcra. There are no vertebral centra, the notochordal sheath being apparently without any ossifications. The opercular apparatus is reduced; there is no jugular plate; the parietal bones are separated by an occipital plate. The gape of the mouth is small, the dentition consists of prehensible teeth on the premaxillary and dentary bones, and oval teeth adapted for crushing on the vomerine and splenial bones (see 225). The family ranges from the Lower Lias to the Lower Eocene; the principal genera are *Gyrodus* (224, *Gyrodus circularis*, from the Lithographic Stone of Bavaria), *Mesturus*, *Mesodon* and *Pycnodus*.

The Eugnathidæ, e. g. *Eugnathus orthostomus*, 226, are a family of fishes which must have been predatory, judging from their large, strong mouth and their teeth, the marginal ones of which are conical and larger than the inner teeth. The body is long and not much laterally compressed, the scales are rhombic, the fulcra large, the fin-rays robust, the dorsal and anal fins short-based. The vertebral centra are rarely more than incomplete rings (hypocentra and pleurocentra alternating), two such rings to each vertebra. The opercular apparatus is complete, with a single jugular plate; the premaxillæ are in contact. The family ranges from the Trias to the Cretaceous.

Amiidæ The family Amiidæ is a small one containing the living *Amia*, a fish which in structure approaches more nearly to the Neichthyes

or Teleostei than do any of the other fishes of the order Astylopterygii. The body is somewhat compressed laterally, and covered with thin, flexible, cycloid scales; the dorsal fin is more or less long and low, the anal fin is short-based; the fin-rays are robust; there are no fulcra, except in *Megalurus*. The tail is nearly homocercal, with a rounded hinder margin; it is distinctly heterocercal in the young. The vertebræ are well ossified (except in *Liodesmus*) and are amphicœlous (*i. e.* the centra are hollow both in front and behind); in the caudal region the half-centra remain distinct. The skull bears a close resemblance to that of the Teleostei, but the vomer is paired, and there is no supra-occipital bone. The opercular apparatus is complete, and there is a large median jugular plate. The premaxillary bones meet, and are not separated as they are in the next family.

The Bow-fin, *Amia calva*, 227, of the North American lakes and rivers, is the sole existing member of the family; it grows to about 30 inches in length; it is voracious and feeds upon crustaceans and insects. The general coloration is a dark mottled green; the male is smaller than the female and is distinguished by the presence of a round black spot encircled by a margin of orange at the base of the tail. The Bow-fin is valueless as food, the flesh being soft, watery and ill-flavoured. The air-bladder is cellular and lung-like, and opens into the dorsal wall of the pharynx. Owing to the high development of the air-bladder as a lung-sac the fish can live out of water for a long time. Bow-fin.

The Pachycormidæ (e. g. *Hypsocormus*, 229) are an extinct family of large-mouthed, predatory fishes related to the Amiidæ. The scales are thin and rhombic, sometimes rounded at the postero-inferior angle. The dorsal fin is short based, with fin-rays slender and closely set, and fulcra few or absent. The ethmoid region of the cranium is fused with the vomerine bones, and is more or less produced in front of the mouth, forming a prominent rostrum which separates the two premaxillæ. The branchiostegal rays are numerous; there is a single, large jugular plate. Some of the teeth are large and conical. Feeble ossifications sometimes occur in the sheath of the notochord, but in most cases the notochord persisted without reduction in Pachycormidæ.

adult life. The family ranges from the Lias to the Lower Cretaceous, and includes the genera *Pachycormus*, *Euthynotus*, *Hypsocormus*, and some others.

NEICHTHYES OR TELEOSTEI

("Modern" Bony Fishes).

The great majority of living fishes, fresh-water and marine, fall under the head Neichthyes or Teleostei. The skeleton of the paired fins consists almost entirely of ossified fin-rays of dermal origin, the row of ossified cartilages (pterygia) with which the basal ends of these are connected being very greatly reduced; except in the reduction of the pterygials the paired fins resemble those of the previous order, the Astylopterygii, and by some authorities the orders Astylopterygii and Neichthyes are grouped together under the same head, the Actinopterygii, characterised by the importance of the dermal fin-rays in comparison with the basal parts of the pectoral fin-skeleton. The muscles of the fin are confined to the basal parts, so that there is no "lobe" to the fin such as occurs in the order Stylopterygii.

The scales are thin, oval and overlapping; in a few cases they are absent, or exist in the form of hard scutes. Only in extinct transitional forms such as *Pholidophorus* are rhombic scales with superficial layer of ganoin present, and the same applies to the fulcra of the fins. The skeleton is mainly bony; the vertebræ are distinct, and the centra are usually hollow in front and behind (amphicœlous). In most cases the hind end of the vertebral column is uptilted, although the outline of the tail fin is symmetrical (homocercal) with an abruptly truncated or forked hind edge. The vomerine bone is single, never paired; there is no splenial bone in the mandible and no exact equivalent to the coronoid bone of the Astylopterygii; there is a supraoccipital bone in the cranium. The infraclavicular bone of the shoulder-girdle is wanting.

The spiracle is closed. The heart has no conus arteriosus (except *Albula*); the intestine has no spiral valve (except *Chirocentrus*); the optic nerves cross one another beneath the brain and do not form an optic chiasma.

Physostomi.

The Teleostei or Neichthyes are divided into two main sections or "grades," the Physostomi and the Physoclisti. In the fishes of the grade Physostomi the air-bladder is usually present, and remains in open communication with the alimentary canal by a tube called the "pneumatic duct." The fishes are, on the whole, less specialised than those of the grade Physoclisti. Included in the Physostomi are the Salmoni-clupeiformes or Isospondyli—the Salmons, Herrings and allied fishes; the Cyprini-siluriformes or Ostariophysi—the Carps and Cat-fishes; the Anguilliformes or Apodes—the Eels; and the Esociformes or Haplomi—the Pikes and their allies.

SALMONI-CLUPEIFORMES (Salmons, Herrings, etc.).

The Salmoni-clupeiformes or Isospondyli are the most primitive of the Teleostei, and approach the Ganoid fishes (e.g. *Amia*) more closely than do other Teleosteans. The suborder includes the Tarpons, Herrings, Mormyrids, Osteoglossids, Salmons and Trouts. The anterior vertebræ are simple and not converted into a mechanical link-work for connecting the air-bladder with the ear as they are in the next suborder, the Cyprini-siluriformes. The maxillary bone forms usually part of the margin of the upper jaw; there are no barbels. The pelvic fins have many rays and are abdominal in position, *i. e.* are set some distance behind the pectoral fins. The shoulder-girdle is connected with the back of the cranium by the post-temporal bone, and has a mesocoracoid element (see girdle of Salmon, 277), a bone found in the pectoral girdle of all Ganoids, but among the Teleostei in the Salmoni-clupeiformes and the Cyprini-siluriformes only. None of the fins have spinous fin-rays.

The families Leptolepidæ (e.g. *Leptolepis dubius*, 232), Pholidophoridæ and Oligopleuridæ include small fishes which occupy a low position among the Neichthyes, and connect them with the Amioid fishes. These fishes are extinct, and their remains are found in Mesozoic strata. In all of them there is an aperture in the middle of each centrum through which passed the more or less

persistent notochord. In the Pholidophoridæ the scales are rhombic, in the other two families they are cycloid. The fins have fulcra in the Pholidophoridæ and Oligopleuridæ, but not in the Leptolepidæ.

Elopidæ. Of the living Teleostean fishes the most primitive are the Elopidæ. This family includes the Tarpon of Florida (*Megalops atlanticus*, 1110, Floor-case 27, and fig. 47), the Ox-eye (*Megalops cyprinoides*, 234), the Ten-pounder (*Elops saurus*, 233), and some extinct forms. The scales are not deciduous as they are in the Herrings (*Clupea*), the dorsal and anal fins are small, the former with short base and situated about the middle of the length of the body; the pectoral fins are set low down the sides of the body; the pelvic fins have 10–16 fin-rays. The mouth is wide and terminal, the teeth are minute and uniform in character. There is a single median jugular plate, a bone which occurs in no other living Teleostean fishes.

FIG. 47.—Tarpon, *Megalops atlanticus*.
(From Boulenger, Camb. Nat. Hist., vii, 1904, after Goode.)

Elops saurus (233) is a fish of wide distribution in tropical and sub-tropical seas, and very common in the open sea along the coast of southern United States, where it is known as the "Ten-pounder." The fish is not valued as food except by such people as the Hawaiians and Japanese who eat fishes raw. The young are delicate and ribbon-shaped, like those of the Lady-fish (*Albula*) and the Eel.

Megalops differs from *Elops* in having large scales (235), a large, short head, with oblique mouth of moderate size, and with a projecting lower jaw; the last ray of the dorsal fin is

produced into a long filament. The Tarpon (*Megalops atlanticus*, 1110, Floor-case 27, also fig. 47) is a littoral fish of warm American seas, and often enters rivers and even inland lakes. It is carnivorous, feeding on Mullets and similar fishes, and grows to a length of seven feet or more and a weight of over 100 lbs. It disports itself noisily in the water, frequently leaping seven or eight feet out of the water and returning head first, with the body bent in the form of an arch, and with the gill-covers widely open displaying the red gills. The Tarpon ranks as the greatest of the game fishes and when hooked affords good sport; it is caught by rod and line from rowing boats. Tarpon.

The Ox-eye, *Megalops cyprinoides*, 234, differs from the Tarpon in being a less slender fish; the dorsal fin is not so far back and has more fin-rays (about 20), as also has the anal fin (about 25). Like the Tarpon it readily accommodates itself to fresh water. When the fishes are small, of about the size of Mackerel, they swim about in shoals, but when larger they are solitary. The Ox-eye rarely attains a length of five feet. It affords most excellent eating, in marked contrast with the Tarpon, and in some parts of India it is preserved in tanks or ponds for table use. Ox-eye.

The Albulidæ (*e.g.* the Lady-fish, 236) have a small mouth, with thick lips, and overhung by the bluntly-pointed snout. There are large crushing teeth in the inner parts of the mouth, and minute, pointed teeth on the bones of the jaws. As in the Elopidæ the pectoral fins are set low down, the pelvic fins have 10–16 fin-rays; the tail fin is well-developed and forked, but the hæmal arches are more or less fused at the base of the tail, whereas in the Elopidæ they remain separate. There are only two living genera, *Albula*, the Lady-fish, and *Bathythrissa*, a deep-sea fish of Japan; remains of *Albula* (*Pisodus oweni*) occur in the London Clay of Sheppey.

The Lady-fish, *Albula conorhynchus*, 236, is a shore fish and subsists mainly upon bivalve molluscs, for the crushing of which its central dentition is well adapted. Full-grown specimens of the Lady-fish range from 20 to 30 inches in length, and from 3 to 10 lbs. in weight. Opinions differ as to the value of its flesh as food. The fish gives good sport to the angler when Lady-fish.

once it has been induced to take the bait, which is a live mussel or cockle left in a position where the fish may be expected to come. The young larval forms are band-shaped and transparent, and shrink considerably in size at the end of the larval stage of existence.

In Sharks, Lung-fishes, Sturgeons, Gar-pikes and Bow-fins there occurs in advance of the ventricle of the heart a small chamber called the "conus arteriosus," the walls of which are of striped muscle-fibre, like those of the ventricle, and the interior of which is provided with watch-pocket valves preventing the blood from passing back into the ventricle. In Teleostean fishes generally there is no conus arteriosus; the ventral aorta, however, is enlarged at its posterior end, where it comes off from the ventricle, and this part is known as the "bulbus arteriosus." Its walls are composed of elastic tissue and plain or unstriped muscle-fibre. In the heart of *Albula* there is a vestigial conus arteriosus, with striped muscle-fibres, and provided on the inside with two rows of valves, two large ones in the front row, and two large and two small in the second row. *Albula* is thus interesting as being a connecting link between the Teleostean fishes generally on the one hand and the Astylopterygian fishes, such as the Gar-pike and the Bow-fin, on the other.

Mormyridæ.

The Mormyridæ are fresh-water fishes of tropical Africa, of curious aspect, and very variable in the form of the head. The scales are small and cycloid; the mouth is often very small and in some cases (e.g. *Gnathonemus curvirostris*, 242) set at the end of an elongated snout; it is bounded above by the premaxillary bones, which are fused together. On each side of the cranium is a large vacuity occupied by a thick-walled air-vesicle, but in the dried skull having the form of a foramen leading into the cranial cavity and loosely covered by a large, thin lamina of bone, the supratemporal. The gill-opening is reduced to a small slit. The eyes are more or less reduced and are often indistinct beneath a thick, semi-transparent skin; the brain is large in proportion to the size of the body. In *Mormyrus* and *Gymnarchus* and some other genera a feeble electric organ occurs on each side of the tail, formed by a modification of the tail muscles into a

gelatinous substance enclosed in regularly arranged connective tissue compartments and supplied with enlarged spinal nerves. In all except *Gymnarchus* there are slender bones, known as Gemmingerian bones, occurring on each side of the tail, above and below the electric organ, the equivalents of which bones have not been recognised in any other fishes. The flesh of Mormyrid fishes is good, and one species, *Mormyrops deliciosus*, 241, derives its specific name from its excellent flavour. *Mormyrus oxyrhynchus* (238, and fig. 48) was venerated by the ancient Egyptians, and the outline of the fish appears frequently in their pictures. The long-snouted forms like *Gnathonemus curvirostris*, 242, search for their food in the mud and beneath stones, the finger-like process on the chin acting as a "feeler," the sensi-

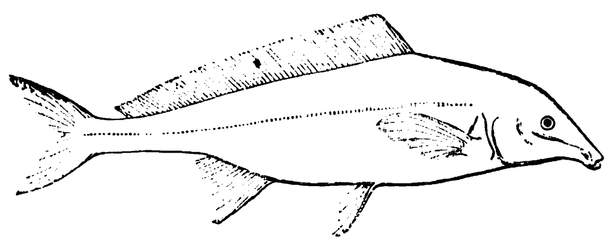

FIG. 48.—*Mormyrus oxyrhynchus*.
(From Günther, "Study of Fishes.")

tiveness of which compensates for the reduction in the power of distinct vision. The species with larger mouths seize small fishes and crustaceans. *Gymnarchus niloticus*, 243, of the Nile and rivers of West Africa, has a long, eel-like body, without caudal, anal, and pelvic fins. The dorsal fin extends the whole length of the body. The jaws have well-developed, chisel-edged teeth. The air-bladder is cellular and very extensible, and is an important organ of respiration. *Gymnarchus* moves through the water by the action of its dorsal fin only; it can move backwards as readily as forwards, and when retreating uses its tapering tail as a feeler. The fish makes a floating nest, which the male guards jealously; the young have external gill-filaments and

a large, pendulous yolk-sac (see 1162, Cabinet-case 29, and fig. 49).

Moon-eye. The Moon-eye, *Hyodon tergisus*, 244, of the fresh waters of North America east of the Rocky Mountains, constitutes a special family by itself, the Hyodontidæ. It is a silvery fish about 12 to 18 inches long, with a large mouth with strong, sharp teeth, and some particularly large teeth on the tongue. There are teeth on the parasphenoid bone, a primitive feature which is common to this fish and *Elops, Megalops, Albula, Arapaima, Osteoglossum, Notopterus*, and most Mormyridæ, but which occurs in no other living Teleostean fishes.

Notopterus. The species of *Notopterus*, constituting the family Notopteridæ, are strange-looking fishes with a much compressed body, a short-

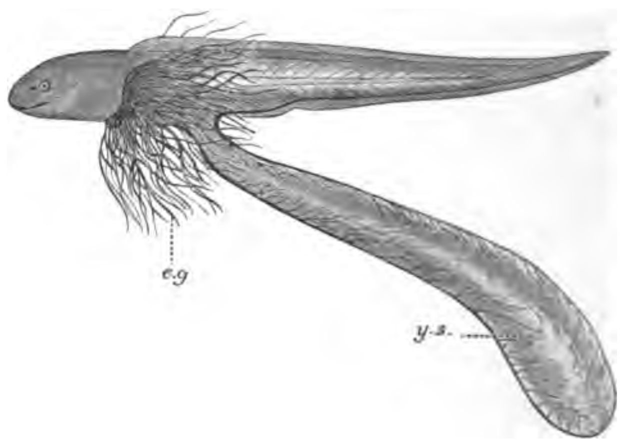

FIG. 49.—Young *Gymnarchus niloticus*, showing the large yolk-sack (*y.s.*) and the long external gills (*e.g.*). (From Bridge, Camb. Nat. Hist., vii, 1904, after Budgett.)

based dorsal fin and a very extensive anal fin, which is continuous with the caudal fin. They are fresh-water or brackish-water fishes found in the marshes and lakes of Africa, India and the Malay Peninsula, and feeding on worms and insects. One of the largest species is *Notopterus chitala* of India (245), which grows to three or four feet in length ; another well-known species is *Notopterus kapirat* (246), also from India and the Malay district. The scales are thin and cycloid, and extend over the

head and gill-covers. The pelvic fins are reduced or absent. The air-bladder is large and complex in structure ; it is connected with the ear by forwardly directed processes which enlarge at their ends into air-vesicles embedded in the side of the hinder part of the cranium, and it sends also a pair of processes back into the tail region.

The Osteoglossidæ are a sharply delimited family distinguished by the sculpturing of the superficial bones of the skull, the robust character of the cheek-plates, the meeting of the parietal bones, the sutural union of the nasal bones with one another and with the anterior ends of the frontal bones, and the presence of a stout, peg-like process of the parasphenoid for articulation with the entopterygoid. The scales are large and thick, and with a mosaic-like structure. The dorsal and anal fins are set back, and their bases are more or less extended. The trunk vertebræ have stout transverse processes for the attachment of the ribs (see Osteoglossidæ.

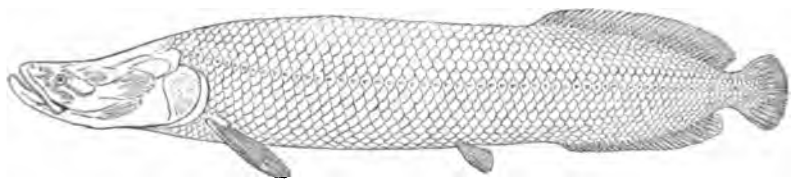

Fig. 50.—*Arapaima gigas.*
(From Boulenger, Camb. Nat. Hist., vii, 1904.)

skeleton of *Arapaima,* 1035, Table-case 50). The Osteoglossidæ are fresh-water fishes of the tropics. The Arapaima (*Arapaima gigas,* fig. 50, 1033 and 1034, Table-case 51, and skeleton, 1035, Table-case 50), locally known as the "Pirarucu," is a great fish of the rivers of Brazil and the Guianas, attaining a length of 15 feet and a weight of 400 lbs. or more. The larger specimen in Table-case 51 is a little under 8 feet in length. The scales are large (250, Wall-case 7), and in the living fish are greenish-brown, with a reddish hind border. The Arapaima is highly esteemed as an article of food; the flesh is cured and salted in a manner similar to that of Cod-fish, and is an important article of local commerce. In the floor of the mouth of the fish is a bone covered with small teeth of uniform size (249) which the natives use as a rasp for scraping into a pulp the flesh of gourds and similar vegetables.

Osteoglossum and *Scleropages* are closely allied genera, the latter with a longer body and with more extended dorsal and anal fins than the former; in both the mouth-cleft as seen from the side is long and oblique, and the lower jaw is prominent and bears a pair of barbels. *Scleropages leichardti* (247) is the "Barramunda" of the Rivers of Queensland, although the name is indiscriminately used for this fish and the *Ceratodus* (171, Wall-case 6). Another species of *Scleropages* occurs in Sumatra and Borneo; *Osteoglossum* occurs in Brazil and the Guianas.

Heterotis (248) is a small-mouthed fish common in the Nile, Gambia and other rivers of tropical Africa. The air-bladder is cellular and probably is used as a breathing organ, and there is an accessory respiratory organ, spirally coiled, above the fourth gill arch. During the breeding season the fish constructs a large nest in a part of the swamp where the depth is about two feet, and here it rears the young, which at one period of their development breathe by external gill-filaments.

Clupeidæ. The Clupeidæ are an important family of fishes including the Herrings, Shads and Anchovies; they are principally coast fishes, widely spread in the temperate and tropical zones, and some of them entering fresh waters communicating with the sea. The dorsal fin is small and set nearly in the middle of the back; there is no adipose dorsal fin. The scales are thin and readily shed; the gill-opening is usually very wide, and the opercular apparatus is complete. The parietal bones are separated by the supra-occipital; in most cases the maxilla assists the premaxilla in bounding the upper border of the gape; the teeth are feeble (except *Chirocentrus*), and two surmaxillary bones are usually present. The postclavicle is applied to the outer side of the clavicular bone, and not to the inner side as in the Salmonidæ. The pelvic fins have 6-11 fin-rays. The stomach is produced back into a blind sac; the air bladder in some cases (*e. g.* Herring) opens directly to the exterior in the vicinity of the anus. Inter-muscular bones are numerous; the ribs are mostly sessile, being inserted behind the transverse processes. The family is well represented in Cretaceous and Tertiary strata.

Dorab. The Dorab, *Chirocentrus dorab*, 253, common in the Indian and Western Pacific Oceans, is a brilliantly silvery fish growing to

three feet in length, with a long, strongly compressed body and a saw-like edge on the belly. The dorsal fin is short-based and opposite to the anal, which is long. One of the most interesting features of *Chirocentrus* is the presence of a spiral valve in the intestine; such a valve is present in all Ganoid fishes, and the occurrence of the valve, even in a reduced form, in this Teleostean fish is of interest as pointing to the relationship between the lower Teleostean fishes and the Ganoids. *Portheus, Ichthyodectes* and *Saurodon* are Cretaceous fishes allied to *Chirocentrus*, but of much greater size and with the teeth lodged in sockets; by some authorities these fishes are placed in a separate family, the Saurodontidæ.

Included within the genus *Clupea* are the Herring, Pilchard, Sprat and Shad, fishes of northern distribution, with deciduous scales, a row of ridge-scales extending along the lower edge of the body from the shoulder girdle to the anal fin, a forked tail, a feeble dentition, and no lateral line. Most of the species are food fishes, but some of the tropical species are poisonous. The Herring, *Clupea harengus*, 255, is found on both European and American sides of the North Atlantic, and is especially abundant in the North Sea and off Norway. It may thus be regarded as a northern and a cold water fish. The "Herring" of the North Pacific is of another species, *Clupea pallasi*. The Herring fisheries of the North Sea take place during the spawning season, which reaches its height in June off Shetland, and in November off Lowestoft. The fishing fleets move southwards as the centre of shoaling shifts from point to point. The spawn of the Herring, unlike that of most other food fishes, even the allied Pilchard and Sprat, sinks to the bottom; but the fish are mostly caught near the surface in drift-nets, which may be more than a mile in length for each boat. About 8,000,000 cwts. of Herrings, valued at more than £2,000,000, are annually landed in Great Britain. The largest Herrings come from Loch Fyne, in Scotland. Herring.

The little fishes that go by the name of Whitebait consist of the fry of Herrings and Sprats, both of which have a predilection for brackish water. The Thames Whitebait consists chiefly of Whitebait.

young Sprats during the winter and young Herrings during the summer.

Pilchard. The Pilchard, *Clupea pilchardus*, 263, unlike the Herring, is a warm water fish, distributed from Cornwall and the South of Ireland to Madeira and the Mediterranean. It is taken in drift-nets and seines, and is fished for near the coast during the feeding migrations, and not when spawning. The fishery fluctuates greatly, but the Cornish take is rarely less than 100,000 cwts. per annum, valued at £30,000. The Pilchard is smaller than the Herring and may be distinguished by its having well-marked radiating ridges on the gill-cover; another test common among the Cornish fishermen is practised by holding the fish by the tip of its dorsal fin: the Pilchard's body hangs horizontally, but that of the Herring dips slightly down at the head end, since the dorsal fin is set a little farther back in that fish than in the Pilchard. The fishes known as Sardines are young Pilchards. The Sardine fishery of the West coast of France is a valuable one, but is subject to great fluctuations, and a scarcity of the fish has at times given rise to a critical situation on the French coast.

Sprat. The Sprat, *Clupea sprattus*, 264, is a small species of *Clupea*, generally distributed around the British Isles and the coasts of continental Europe. It may be distinguished from young Herrings by having no teeth on the vomerine bone, and by having only a single air-vesicle in the ear instead of two; careful dissection is required for the application of this latter test, but it is the most reliable one that can be adopted in discriminating between Sprat Whitebait and Herring Whitebait.

Shad. Of the Shads, two are caught on the coasts and in the estuaries of Britain, the Allis Shad, *Clupea alosa*, 256, and the Thwaite Shad, *Clupea finta*, 257; there is no regular fishery for Shad in British waters as there is in the Rhine and some of the other large rivers of continental Europe. The average size of the Allis Shad is that of the specimen exhibited (3 lbs.), the Thwaite Shad is usually smaller. The Thwaite and Allis may be distinguished by the former having 21–27 stout, rigid gill-rakers on the first gill arch and the latter 60–80 very fine, long and flexible gill-rakers on the first arch (259 and 258).

The American Shad (*Clupea sapidissima*) is closely allied to our own Shads, and its flesh is said to be superior in flavour. The United States Fisheries Commission has achieved great success in its efforts to propagate the Shad in nurseries and to liberate the little fishes on hatching, with the result that the Shad is now declared to be one of the best and cheapest fishes in the American market. The Commission has also been successful in transplanting the Shad from the Atlantic coast of North America to the Pacific coast, in the waters of which it did not previously exist, and where it now abounds from Puget Sound southwards to Point Concepcion, ascending the rivers to spawn in May as it does on its native coast. In consequence of the attention that has been bestowed upon it, the *Clupea sapidissima* is commonly dubbed the "Commission Shad."

Another important American fish is the Menhaden or Mossbanker, *Clupea menhaden*, common on the Atlantic coast of the United States. It is a coarse and bony fish, rarely eaten when adult, but valuable on account of the rich oil which it yields in abundance; the refuse after the oil has been extracted from the fish is used as a manure for the corn-fields; the fresh fish is largely used as bait.

Hyperlophus (270) is a genus of fishes found at the present day in the rivers and on the coasts of Chili and New South Wales, and occurring in a fossil state in the Upper Cretaceous rocks of Syria, Southern Europe and South America, and in the Eocene shales of the Green River, Wyoming. It is distinguished from the genus *Clupea* by having not only a row of ventral ridge-scales, but a row of dorsal ridge-scales extending from the back of the head to the dorsal fin.

The Hickory-Shad, *Chatoëssus* or *Dorosoma*, 267, is a deep-bodied fish of the rivers and estuaries of Eastern America, Eastern Asia, and Australia, with small, toothless mouth, a reduced maxillary bone, and a suprabranchial accessory organ of respiration over the fourth gill arch. The stomach is muscular and thickened, and has the form of a hickory nut, whence the name Hickory-shad given to these fishes by the Americans; the name is applied in particular to the species *C. cepedianum* of the rivers and estuaries of the Eastern United States. The belly is serrated,

the last ray of the dorsal fin prolonged and whip-like, the gill-rakers are fine and form a strainer for the mud in which these fishes find their food.

Anchovy. The Anchovy, *Engraulis encrasicholus*, 268, has no ridge-scales; the body scales are large, there is no lateral line, the snout is conical and projects beyond the front of the lower jaw, the mouth cleft is large, the maxillary bone long and slender, and the premaxillary small. The European Anchovy is largely preserved either in oil or packed in small barrels with salt, bay-leaves and spices, or the flesh is made into a paste or sauce for use as a relish with other fish served as food. The Anchovy is especially abundant in the Mediterranean, but occurs also in numbers in the Zuyder Zee and other parts of Holland; it does not occur regularly in British waters.

Coilia nasus, 269, a fish of the Indian and China Seas, is allied to the Anchovy; it is of larger size and has a long tapering tail and a long-based anal fin continued on to the tail. Two or three of the uppermost fin-rays of the pectoral fin are prolonged and freely branched, and there is a remarkable backward extension of the maxilla which is toothed for its whole length in spite of the fact that only the anterior portion of that bone engages with the lower jaw.

Milk-fish. The Milk-fish, *Chanos salmoneus*, 266, departs from the typical Clupeoids in the reduction in the size of the mouth, the absence of teeth in the jaws, and a number of other features of the skull. The tail fin is deeply forked and has a scaly lamella at the base of each lobe; there is a distinct lateral line, and an accessory branchial organ behind and above the gills. The fish is very swift in the water, and grows to about 4 feet in length. It is abundant in the Gulf of California, the Indian Ocean and Polynesian seas; it is largely used as food in Hawaii, where it is known as the "Awa."

Salmonidæ. The Salmonidæ are an important family of fishes having a small adipose fin, a thick, fat-laden fin without fin-rays, between the dorsal fin and the tail. The pectoral fins are inserted low down the sides of the body, the post-clavicular bone is applied to the inner side of the clavicle; there are no barbels, the margin of the upper jaw is supported by both the premaxillary and the maxillary

bones, and there is a single surmaxilla. Most of the fresh-water forms are peculiar to the temperate and arctic regions of the northern hemisphere, but one (*Retropinna*) occurs in New Zealand; most of the purely marine forms are from the deep sea. Many species are anadromous in habit, *i. e.* living in the sea, but entering fresh water to spawn and descending again to the sea afterwards.

The genus *Salmo* is one of great interest, not only because of the value of the fishes of the genus for purposes of food and the sport which their capture affords, but because of their plasticity and ready response to altered conditions of life. As a rule the fresh-water forms are brown and the marine forms bright and silvery, and the change from the one colour to the other may, in the migratory forms, be observed in the same individual at different periods of its life. In the non-migratory forms the colours are fairly constant while the fish remains in the same waters, but by transferring to new localities brown forms may become silvery and silvery ones brown. If the colouring of the body be disregarded the British species of *Salmo* may be counted as three in number:—*Salmo salar,* the Salmon and its varieties, *Salmo trutta,* including all the Trouts, such as Salmon Trout, Bull Trout, Great Lake Trout, Brook Trout, and *Salmo alpinus,* including all the Charrs. For fuller details of the varieties the visitor is referred to the series exhibited in Cabinet-case 43, and to the specimens in the Wall-case in the British Collection at the West end of the Bird Gallery.

Salmon.

The true Salmon, *Salmo salar,* 276, is confined to the northern hemisphere between latitudes 75° and 41° or 43° N.; it occurs in America and Asia as well as in Europe, and does not exist in the Mediterranean and the rivers flowing into it. In Britain the Salmon comes up from the sea into fresh water usually from September or October to January. The nest or redd is dug in the gravel by the female, and after being fertilised by the male, the eggs are buried. The newly hatched fry, or Alevins (272), become free about 90 days after the eggs are laid; they grow to 4 or 6 inches in length, when they are known as Parr or Pink (273); the body is marked by vertical blue bars and large spots and is not silvery. The fish either in the first year, or more usually in the second year, lose the parr marks, and become Smolts

(274) and commence their descent to the sea. They are then about 8 inches long and silvery in colour. On its first return from the sea the fish is known as a Grilse (275) or Salmon Peal; such a fish would weigh 3 lbs. if caught in the river in June, but a Grilse that had delayed its return to fresh water till the end of July would weigh 9 or 10 lbs. if in good condition. The term "Salmon" is only applied to a fish on its second and subsequent ascents. A Kelt is a spent Salmon, one which has spawned and is returning to the sea. A Kipper is a lean Salmon which has failed to descend to the sea after spawning. In mature male Salmons the upper and lower jaws become enlarged at the front and bent over, the lower jaw being particularly hooked, and giving a sinister appearance to the head.

The Salmon only comes up the rivers to spawn; it does not feed in fresh water, judging by the absence of food-material in the stomachs of fishes examined, and it is this circumstance which renders so unaccountable the fatal fascination exercised by that wonderful tuft of feathers and coloured wool which anglers term the "fly". The pink colour of the flesh of the Salmon is attributed to its feeding on crustaceans such as shrimps and prawns.

The excellence of the Salmon as a food fish has rendered Salmon-fisheries the object of constant attention on the part of the legislature from the earliest times of which we have any record. The fisheries form an exceedingly valuable part of the natural wealth of the country. In Scotland the rateable value of the Salmon-fisheries in those districts where Fishery Boards have been formed was assessed in the year 1898 at over £107,000. The Salmon carried to market by the railways and steamers of Scotland amounted to 4,230 tons in 1895 and to 2,093 tons in 1898. The heaviest British Salmon on authentic record is one taken in the Tay which weighed 70 lbs. It must be borne in mind, however, that some of the large fish which the Tay anglers call Salmon are really Bull Trout, and the 70 lb. fish may have been such a fish. In the British Pavilion, at the end of the Bird Gallery, is exhibited a Bull Trout from the Tay weighing 55 lbs.

The Salmon 276 in Wall-case 7 of this Gallery weighed 33 lbs. when caught; it was taken in the Tay at Perth in July.

The Sea Trout or Salmon Trout, 279, a migratory form of *Salmo trutta* coming up from the sea into fresh water to spawn, is a coarser fish than the Salmon (*Salmo salar*); the flesh is not so pink, is of drier texture, and is less richly flavoured. Large specimens of the Sea Trout are known as Bull Trout. The Sea Trout may be distinguished from the Salmon by its smaller and more numerous scales, there being 14 to 16 scales in a line passing downward and forward from the hind edge of the base of the adipose fin as far as the lateral line, not counting the lateral line scale, whereas in the Salmon the number is 11 or 12. The root of the tail is stouter and of more clumsy appearance in a Sea Trout than in a Salmon, and the hind border of the tail fin changes from the concave to the flat, and ultimately to the slightly convex shape, earlier in the Trout than in the Salmon. The anal fin is larger and set farther back, and the anterior fin-rays relatively longer than in the Salmon. The gill-cover has the hind edge more angulate and less semicircular than in the Salmon, and has usually more spots upon it. The side of the body has more black spots below the lateral line than that of the Salmon. When the mouth is closed the hind end of the upper jaw (maxilla) is farther back than in the Salmon, and the first branchial arch has 17 or 18 gill-rakers, whereas that of the Salmon has usually 20. The breeding habits of the Sea Trout are much the same as those of the Salmon; the Smolts are readily distinguishable from Salmon Smolts by having yellow pectoral fins. The Grilse of the Sea Trout is known as Phinok. Sea Trout.

The Brook Trout or Brown Trout (280), the variety *fario* of the species *Salmo trutta*, is a form which is confined to fresh water, and lives in brooks, streams and ponds of European countries. In Britain it does not run much over 10 lbs. in weight; in the river Thames in the year 1907 Trout of 8 lbs. were caught on three occasions; in the same year a Trout was caught in the New River weighing 18 lbs., but fish of this size are very exceptional. Brook Trout.

Salmo alpinus includes the Charrs of Britain, varieties of which from Buttermere, Windermere, and Sutherland are shown in Cabinet-case 43. The Swiss Charr, 284, the "Omble chevalier" of the Swiss lakes, is a red Charr of the variety *umbla*. The Charr.

American Charr, *Salmo fontinalis*, 281, which the Americans call their "Brook Trout," has been introduced with success into Britain, as also has the Rainbow Trout, *Salmo irideus*, 282, but the colours of the acclimatised Rainbow Trout are not so brilliant as those of the fishes in their native mountain streams in the Rocky Mountains.

The Namaycush or Lake Trout of North America, *Salmo (Cristivomer) namaycush*, 285, is a non-migratory Trout, with deeply-forked tail fin and strong teeth, inhabiting all the Great Lakes of the northern part of North America. The fish is grey, not brown as are most non-migratory Trout; it is a sluggish, heavy-looking, ravenous fish, attaining an average weight of 15 to 20 lbs. The North Pacific Salmon or Quinnat Salmon (1099, near Table 25), has more fin-rays in the anal fin than our *Salmo*, and is placed in a separate genus, *Onchorhynchus*. It is migratory, and similar in habits to our Salmon and Sea Trout. A large proportion of the tinned Salmon that is sold in England is the flesh of the Quinnat Salmon of British Columbia and Alaska. The average weight of the fish is 22 lbs., but individuals of 70 to 100 lbs. are occasionally taken.

Quinnat.

The genus *Coregonus* includes the various White-fish, fishes of the northern parts of temperate Europe, Asia, and North America,

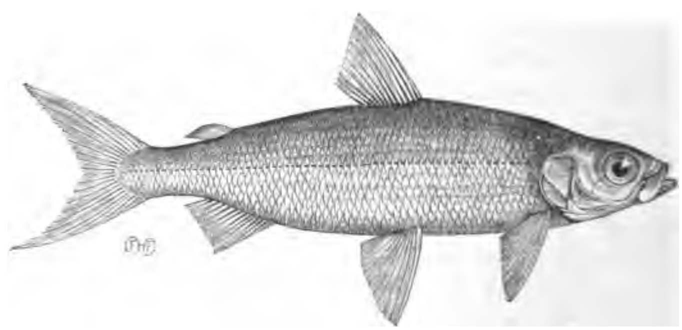

FIG. 51.—Vendace, *Coregonus vandesius*.

and mostly lacustrine and rigidly localised, although a few are anadromous in habit. The mouth is smaller and shorter than that of *Salmo*, the maxillary bone not extending back below the

eye; the teeth are minute or wanting; the tail fin is deeply forked; the scales are moderately large, and the ova are small. The commoner species are *Coregonus oxyrhynchus* (291), the Houting of the seas and rivers of Holland, Germany, and Denmark; *Coregonus vandesius,* the Vendace (287, fig. 51), of fresh-water lochs of Scotland, particularly Loch Maben; *Coregonus pollan* (288), the Pollan, of the fresh waters of Ireland, particularly Lough Neagh, where at certain seasons of the year it used to be an important marketable fish; and *Coregonus clupeoides,* the Gwyniad, 290, of Wales, the Lake District and Loch Lomond. The name Gwyniad is usually restricted to the variety of *Coregonus clupeoides* that occurs in Lake Bala in North Wales. The variety found in Loch Lomond is called the Powan, and that of Haweswater and Ullswater the Schelly or Skelly. The "Fera" of the Swiss Lakes (289) is represented in Bavaria, North Prussia and Sweden by varieties which are known respectively as Bodenrenke, Maräne and Sik. *Coregonus clupeiformis* (*Argyrosomus artedi* of the Americans), 286, is the well-known Lake Herring or Cisco of the great Lakes Erie and Ontario of North America. Pollan and Gwyniad.

The Grayling, *Thymallus vulgaris,* 293, of the clear streams and lakes of Central and Northern Europe is distinguished by its high dorsal fin, which is supported by about twenty fin-rays, the most anterior ones of which are simple and unbranched. The fish derives its generic name from its emitting an odour resembling that of thyme. The Grayling breeds in April and May, whereas Salmon and Trout breed in October to January, and it thus affords sport during the close time for the usual Salmonoids. In English streams it grows commonly to 2 or 3 lbs. in weight. *Thymallus vulgaris* is confined to Europe, but there are other species, one, known as the "Poisson bleu," in Canada. Grayling.

The Argentines are deep-sea Salmonoids found in the Mediterranean, the Arctic and North Atlantic Oceans. The common Mediterranean species is *Argentina sphyræna*; a northern form, *Argentina hebridica* (295), found off the North of Ireland, Scotland, and more particularly off Norway, finds its way occasionally to the English markets. The Argentines are sometimes called Siel-Smelts.

Smelt. The Smelt, *Osmerus eperlanus*, 294, is a delicate, semitransparent fish, which emits a peculiar and not unpleasant odour. In habits it is gregarious, and it is essentially estuarine, at least in Great Britain, and frequents only those rivers which enter the sea through long winding channels in extensive mud flats. The Smelt rarely exceeds nine inches in length; as a delicate table fish it takes high rank.

The Candle-fish, *Thaleichthys pacificus*, 296, a fish about nine inches in length, ascends the Columbia River, Fraser River, and streams of Southern Alaska in the spring in immense numbers for the purpose of spawning. Its flesh is white and of excellent flavour. It is so charged with oil that the dried fish, with a cotton wick drawn through the body, will burn like a candle. The local name is Eulachon or Oolachan.

Capelin. The Capelin, *Mallotus villosus*, 292, is a fish of the coasts of Arctic America and Kamtschatka, six to nine inches in length, with large paired fins, a feeble dentition, a prominent mandible, and with small scales, four longitudinal bands of which become greatly produced in the males and cause the body to look shaggy, whence the specific name *villosus*.

Salanx (297) is a small, slender, transparent, whitish little fish, two to seven inches in length, which lives at a considerable depth in the sea, and ascends the rivers of China and Japan at certain seasons to spawn. The fish is called Ice-fish on account of its transparency. The "Whitebait" of Canton consists of *Salanx chinensis*, and is considered a great delicacy.

Alepocephalus. The Alepocephalidæ constitute a characteristic family of deep-sea fishes having affinities with the Salmonidæ and the Clupeidæ. They are of remarkable appearance and wide distribution, occurring between the depths of 300 and 2,000 fathoms in many parts of the world. The dorsal fin is set far back and there is no adipose fin. *Alepocephalus rostratus* (298) of the Mediterranean has cycloid scales, but scales are wanting in some of the genera. *Aulostomatomorpha* (984, Cabinet-case 44) of the Indian Ocean has the snout much produced, and a uniformly luminous head. The skeleton of these fishes is feebly ossified.

Stomias. The Stomiatidæ are aberrant, deep-sea fishes, readily distinguishable from other deep-sea fishes by having the maxilla

longer than the premaxilla, and beset with teeth. Scales are absent or are exceedingly delicate; luminous spots, regularly arranged, are present in most of the species. The eyes are large, a hyoid barbel is frequently present, the gill-opening is wide, the opercular skeleton reduced. An adipose fin is present in some genera. The fishes are predatory and some have a formidable dentition. The chief genera are *Stomias* (299), *Malacosteus* (fig. 5, 979, Deep-sea Series, Cabinet-case 44), *Chauliodus* (fig. 8, 975, Cabinet-case 44) and *Sternoptyx*, the last two being by some authorities placed in a special family, the Sternoptychidæ. Within the family Stomiatidæ examples occur of the reduction of the pectoral fins before the pelvic; in cases in which the paired fins undergo reduction it is almost always the pelvic fins which disappear first, *e.g.* among the Eels, Sand-launces, Blennies and Scabbard-fishes.

Gonorhynchus.

The Gonorhynchidæ (300) are aberrant fishes, the affinities of which are not definitely known; they have been associated by various authors with the Cyprinoids, the Scopeloids, and the Salmonoids. The body is long and cylindrical, without adipose fin. The scales are narrow, small and with spiny edge, deeply imbricated, and extending over the cheeks and gill-covers as well as over the body. The snout is more or less pointed, with a single barbel. The mouth is small and toothless; it is inferior in position and is surrounded by thick, fringed lips.

CYPRINI-SILURIFORMES (Carps and Cat-fishes).

Wall-case 8.

The Cyprini-siluriformes, also known as Ostariophysi, are a suborder of fishes which, though many exhibit remarkable differences in general appearance, all agree in the coalescence of the foremost vertebræ, usually four in number, and the detachment of some of their lateral parts to form a link-work known as the Weberian ossicles, which serve to connect the air-bladder with the ear (see specimen 366 in Wall-case 9). The fishes agree with those of the previous suborder, the Salmoni-clupeiformes, in the presence of a mesocoracoid bone in the pectoral girdle, a bone which does not occur in any of the suborders that follow. The fins are without spines, or the dorsal and pectoral fins may

have a single spine each. The great majority of the fresh-water fishes of the world belong to this suborder, the principal forms included being the Characinids, the Electric Eel, the Carps and Cat-fishes.

Characinidæ. The Characinids are fresh-water fishes occurring in Central Africa and South America, with the jaws usually well armed with teeth, which differ much in shape and arrangement in the genera comprised. The body is covered with scales, an adipose dorsal fin is often present, and there are no barbels.

Tiger-fish. The Tiger-fishes, as the species of *Hydrocyon* (306) are called, are among the most formidable of the Characinidæ. They grow to the size of the Salmon, and on account of the powerful jaws armed with strong teeth, visible when the mouth is closed, and on account of their vicious disposition, they are justly dreaded. The Tiger-fishes are found in the rivers and lakes of tropical Africa, and in the Nile district are known as Kelb-el-Bahr or Dogs of the Water.

Cariba. The Piranha or Cariba, as the species of *Serrasalmo* (313) and *Myletes* (308) of South America are called, are not less ferocious than the Tiger-fishes of Africa. Their bite has been compared to the cut of a razor. They abound in some rivers and bite pieces of flesh out of the legs of persons entering the water; the smell of blood attracts others in great numbers, and the situation of a person swimming becomes very critical. They do not exceed two feet in length. One of their principal distinguishing features is the serration of the belly.

A skull of *Salminus* (311) is exhibited to show the cheek-plates and the characters of the dentition. *Salminus* is an American genus, the largest species being the "Dorado" of the Spaniards, *Salminus orbignianus*, which grows to a length of three feet and is of predaceous habits, pursuing other fishes moving in shoals. *Macrodon* and *Erythrinus* (305) of tropical America are examples of Characinids not possessing the adipose dorsal fin.

Nile Moon-fish. The Moon-fish of the Nile, *Citharinus geoffroyi*, is represented by a skeleton (314), which shows the feebleness of the dentition of this herbivorous fish, and the deep, compressed form of its body. The fish is often depicted on the monuments of the ancient Egyptians.

Although the fishes of the family Gymnotidæ have long, eel-like bodies (fig. 52), and *Gymnotus* itself is called the "Electric Eel," they are not related to the Eels. The presence of the Weberian ossicles in the Gymnotidæ and their absence in the Eels is alone sufficient to satisfy one that the resemblance is superficial only. The Gymnotidæ are in all probability degraded forms of Characinidæ. They are confined to the fresh waters of Central and South America. Gymnotidæ.

The Electric Eel (315) grows to a length of eight feet. It is found in the marshes and shallow parts of rivers of the northern part of South America, and renders the fording of such rivers dangerous, since the horses frequently fall when they receive an Electric Eel.

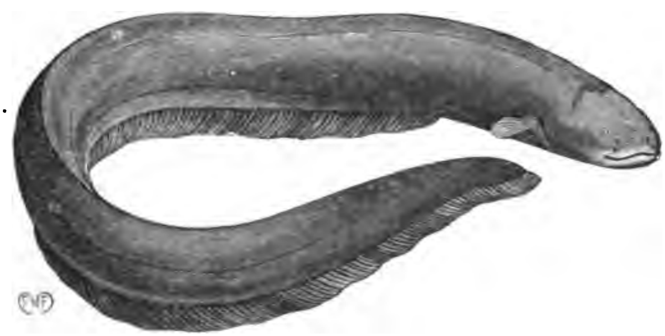

FIG. 52.—Electric Eel, *Gymnotus electricus.*

electric shock from the fish. After delivering two or three shocks the fish is exhausted, and is harmless for a time, and although Humboldt's story of the natives catching Electric Eels by first driving horses into the water for the fishes to discharge their shocks upon has not been confirmed by later travellers, it may nevertheless be based on fact.

Gymnotus is the only member of the family Gymnotidæ which possesses electric organs. These organs are composed of modified muscular tissue; they are richly supplied with nerves connected with the spinal cord, and they consist of compartments with fibrous walls enclosing a stiff jelly, arranged in the form of a band

along each side of the tail, which constitutes nearly the whole of the length of the body, for the anus is set very far forward, under the throat. Similar but smaller electric organs occur in the base of the anal fin.

Cyprinidæ. The family Cyprinidæ, including the Carps and their allies, is composed of fishes with a small mouth-opening, and with no teeth in the jaws, but by way of compensation the gill-teeth, borne by the lower bones of the last gill-arch, are very strongly developed—see, for instance, those of the Mahseer, 331, in the upper part of the case—and the bones themselves are sharply bent (falciform), one of the distinctive features of the family. These pharyngeal teeth are disposed in one, two or three rows on each side. The body is clothed with scales and there are no bony scutes in the skin such as occur in the next family, the Siluridæ or Cat-fishes; there is no adipose dorsal fin. These fishes feed mostly on vegetable substances or small animals.

The Cyprinids are abundant in the fresh waters of the Old World and North America; there are comparatively few species in Africa, where they coexist with the Characinids, and they are absent from South America, where the Characinids take their place as the predominant fresh-water fishes. They do not occur in Australia.

Suckers. The Suckers of the lakes and rivers of North America are species of *Catostomus* (e.g. *Catostomus teres,* 316); they have thick, fleshy lips and no barbels; the dorsal fin extends over a considerable portion of the back and the anal fin is short in the base. The pharyngeal teeth are numerous and are arranged in a single row, forming a kind of comb (317).

In the Carps, as the various species of the genus *Cyprinus* are called, the pharyngeal teeth are arranged in three series and bite against a well-developed hard pad supported by a down-growth of bone from the base of the cranium. The Carps are indigenous in the temperate regions of Asia, but many have been introduced into European waters and have become thoroughly naturalised.

Carp. The Common Carp, *Cyprinus carpio* (318), was introduced into Europe in the thirteenth century, and was first brought into England in the beginning of the seventeenth century. The Carp

subsists on vegetable food and small animals, such as aquatic insects, small pond-snails and worms, and can live for some time out of water. It delights in tranquil waters, particularly those with a muddy bottom and partially shaded by trees; it is a fish of sluggish habits except during the breeding season, when it becomes very excited and frequently leaps out of the water. The Carp is eaten in inland countries, but it is not valued in parts where sea fish are obtainable. Carps have been known to live to a great age (50 to 100 years), and to attain a weight of 20 to 50 lbs., and a length of four feet or more.

Mirror Carp.

In a state of domestication there have arisen two breeds of Carp that tend to lose their scales. In Central Europe there is one form known as the Mirror Carp or "Spiegel-karpfen" (320) which retains large, bright scales along the side of the body and large dull scales on the back, and another form, the Leather Carp or "Leder-karpfen" (319), which has very few scales, if any at all, and the skin is thick and leathery.

Crucian Carp.

The Crucian Carp, *Cyprinus vulgaris* (322), differs from the Common Carp in having no barbels, and in the different arrangement of the pharyngeal teeth. The iris is silvery, whereas in the Carp it is golden. This fish rarely exceeds six or seven inches in length, but may weigh as much as 2 lbs. The Crucian Carp was probably introduced into England from Hamburg, for in the earliest references to this as an English fish it is called the "Hamburg Carp." The term Crucian is evidently a corruption of "Karausche," the German name of the fish. The Prussian Carp is but a lean and elongated variety of the Crucian Carp.

Gold-fish.

The Gold-fish (323) is a golden yellow or red breed of Carp-like fish produced as the result of artificial selection in China and Japan; it has been introduced into Europe and America as an ornamental fish for aquaria and ponds in gardens and parks. The brilliancy generally diminishes when the fish are kept in the open, and they tend to revert to their original greenish colour. Many varieties and monstrosities of the Gold-fish have been produced as the result of domestication, and, in the case of their tails, of mutilation.

Catla.

The Catla, *Catla buchanani* (324), is a large Indian fish; it is Carp-like, but the head is more arched between the eyes, there are

no barbels, the rami of the mandible are loosely connected, and the dorsal fin is shorter. The Catla attains a length of six feet and a weight of 100 lbs. It ranges through India to the Kistna, and eastward through Bengal and Burma to Siam.

Mahseer. The Mahseer or Mahsir or Mosal, ***Barbus mosal*** (329, and fig. 53), is recognisable by the strong smooth dorsal spine, seven or eight branched rays in the anal fin, the fleshy lips, and the very large scales, of which there are 25 to 27 along the lateral line. It is the principal freshwater game fish of India, where it occurs particularly in mountain streams. The Mahseer attains a weight of 250 lbs., although the usual size of fish captured is 12 to 15 lbs. Specimens under ten pounds are good table-fish, but the flesh of larger fish is coarse and oily. The Mahseer is a carnivorous fish, preying chiefly on fishes.

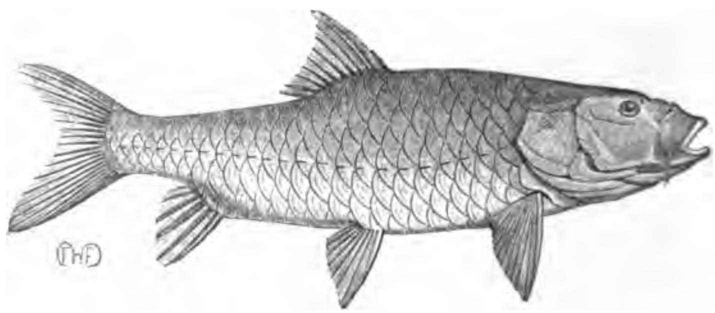

FIG. 53.—Mahseer, *Barbus mosal.*

Barbel. The only species of ***Barbus*** found in British waters is the Barbel, ***Barbus vulgaris*** (327), and this is restricted to the valleys of the Thames and Trent. On the continent the Barbel abounds in almost all the rivers of Central Europe. The Barbel is long for a Cyprinoid fish; the head is elongated, with a projecting fleshy upper lip and small eyes set high up and far back. Four barbels hang down from the upper lip, two from the fore part of the snout and two from the angles of the mouth. It is from these conspicuous "feelers" that the fish takes its popular name. Specimens of 18 lbs. have been taken from the Thames, but at the present day it is rarely that one over 12 lbs. is caught. The Barbel are sociable fishes and collect in shoals where food is

plentiful. They are ground-feeders and are not very fastidious in their diet. The Barbel is rarely eaten except by the poorest people, its liability to convey tape-worms unless the flesh be very thoroughly cooked rendering it undesirable for the table. The roe, also, is sometimes poisonous.

Gudgeon.

The Gudgeon, *Gobio fluviatilis* (332), is a small fish similar in general proportions to the Barbel, but having only two barbels instead of four, and lacking the spine in front of the dorsal fin which the Barbel possesses. The Gudgeons prefer clear running water, although on the continent they are found in still lakes. They are gregarious, moving about in large shoals; they feed on small animals, such as insect larvæ, crustaceans and worms. In England the Gudgeon grows to six inches.

Roach, Chub, Dace, &c.

The species of *Leuciscus*, known in a general way as "White-fish," are abundant in the temperate parts of Europe, Asia and North America. Of the European forms the commonest are the

FIG. 54.—Lower Pharyngeal Bones of the Chub, showing the teeth.

Roach, *Leuciscus rutilus*, 341, spread all over Europe north of the Alps; the Chub, *Leuciscus cephalus*, 338, with a more southern distribution, extending even into Asia Minor; the Dace, *Leuciscus vulgaris*, 343; the Ide or Nerfling, *Leuciscus idus*, in the northern and central parts of Europe, but absent from Britain; the Rudd or Red-eye, *Leuciscus erythrophthalmus*, 335; and the Minnow, *Leuciscus phoxinus*, 334. The scientific differences between the above species are based on the position of the dorsal fin, the number of scales in the lateral line, the arrangement of the pharyngeal teeth (see fig. 54), and the numbers of fin-rays in the several fins.

The Roach grows to 2 or 2½ lbs. The Rudd is deeper in

the body than the Roach, and the pelvic fins are farther forward relatively to the front point of the base of the dorsal fin. The eye also is redder. The Chub is readily distinguished by its thick, plump body and its heavy head. It rarely exceeds 5 lbs. and a length of 20 inches, although larger specimens are on record. The Dace is generally recognised by anglers by the absence of red colour in the pelvic and anal fins, and by the pure silvery colour of the sides of the body. The maximum weight is about 1 lb. The Minnow seldom exceeds 3 inches, although in favourable localities it may attain twice that length. The long, thick body and the brown and green colouring distinguish it from the young of any of the above species of *Leuciscus*.

Orfe. The Ide or Nerfling, *Leuciscus idus*, is a European species which in Germany is domesticated and assumes more or less the golden hue of the Gold-fish. Such forms are known as Golden Orfe, 344.

Azurine. The fish known as the Azurine, 337, is a bluish variety of the Rudd; it occurs in the middle of continental Europe, and at one time was found in some parts of England, for instance, at Knowsley in Lancashire.

Tench. The Tench, *Tinca vulgaris*, 345, is found all over Europe in stagnant waters with a muddy or clayey bottom. The scales of the fish are small and deeply embedded in the skin, which is thick and slimy. A short barbel occurs at the angle of the mouth on each side; the pharyngeal teeth, 347, are wedge-shaped, slightly hooked at the end, and arranged in a single series. The Tench is an animal of leisurely movement and sluggish disposition, except during the breeding-season, and passes the winter in a state of torpidity. In England the Tench seldom exceeds 4 lbs. in weight. In a state of domestication the Tench may be made to acquire a golden colour similar to that of the Gold-fish and the Golden Orfe. Such a fish is called a Golden Tench, 346.

Bitterling. The Bitterling, *Rhodeus amarus*, 348, is a small European fish, the female of which deposits its eggs in the mantle-cavity of the Pond-Mussel by means of a long external genital tube or ovipositor, which is developed in the breeding-season and dwindles away afterward. Sometimes the tube is as long as the fish itself. The eggs undergo their early development in the gills of the

Mussel, and the fry take their departure in about a month's time. The young fishes cannot be regarded as parasites in the gill of the mollusc, since they subsist solely on the yolk that is present in the egg. All that they enjoy is apparently the safety of the secluded position and a current of fresh water which the Mussel keeps circulating through its gills for its own respiratory processes. The young of the Pond-Mussel, when discharged by their parent as free-swimming little creatures, have a way of hooking themselves on to the skin of freshwater fishes, and living embedded in the skin for some time before they escape and settle down in the mud to complete their growth. The breeding-seasons of the Mussel and the Bitterling coincide, and the Mussel takes its revenge, so to speak, on the Bitterling by discharging its own young upon the mother-fish, so that the skin of the latter becomes a nursing-ground for the young Mussels.

Bream.

The Bream, *Abramis brama,* 349, may be distinguished from the other fresh-water fish of Britain by the great depth of its laterally compressed body and the considerable length of the base of the anal fin. The dorsal fin has a short base and stands high, and the lower lobe of the tail-fin is longer than the upper. The scales are rather large and number 51 to 57 along the lateral line. The Bream is as much at home in rivers as in lakes, and is found in most parts of temperate Europe north of the Alps. The fishes swim in large shoals and feed partly on water-weeds and partly on aquatic insects and worms. The average weight of a Bream in England is between 2 and 4 lbs., but a specimen has been caught in the Serpentine, in Hyde Park, weighing more than 7 lbs., and larger sizes are on record.

Bream-flat.

The White Bream or Bream-flat, *Abramis blicca,* 351, is a smaller fish than the Common Bream, and in England not so abundant. It is one of the commonest fishes of Central Europe. The colour is whiter and more silvery than that of the Bream, and less brown and brassy, the lobes of the tail-fin are not so unequal, and the pharyngeal teeth are arranged in two rows on each side instead of in a single row. The fish rarely exceeds 1 lb. in weight, or a foot in length.

Hybrids.

The Carp family is remarkable for the fact that some of the different forms cross-breed in a state of nature, *i. e.* not in

an aquarium, and produce (apparently) fertile hybrids. The Pomeranian Bream, *Abramis buggenhagii*, 1161, Cabinet-case 31, is in all probability a hybrid between the Common Bream, *Abramis brama*, 349, and the Roach, *Leuciscus rutilus*, 341. The characters of the Pomeranian Bream are intermediate between those of the Common Bream and the Roach, and the fish occurs in localities where both the Common Bream and the Roach exist, in England, Holland, Germany, Austria, &c. *Bliccopsis erythrophthalmoides*, 1168, Cabinet-case 31, a fish found in Holland and Germany, is regarded as a natural hybrid between the Bream-flat, *Abramis blicca*, 351, and the Rudd, *Leuciscus erythrophthalmus*, 335, and several other hybrids are recorded between species of *Leuciscus* and those of *Abramis*, *Alburnus* and *Chondrostoma*. A hybrid is also supposed to exist between the Roach and the Rudd, and such a form has been described under the name *Leuciscus affinis*.

Natural hybrids, *i.e.* the offspring of different species pairing in a state of nature, are extremely rare, but within the class of Fishes there is yet another instance which may be regarded as genuine, and that is the hybrid between the Turbot and Brill (1167, Cabinet-case 31). The Grimsby fishermen occasionally come across a fish which is intermediate in characters between the Turbot and the Brill and which they call a hybrid. Since it has been found possible in the artificial conditions of a marine laboratory to fertilise the eggs of the one species of fish with the sperms of the other and to rear the young up to a certain stage of development, it is very possible that they may be right.

Bleak.

The Bleak, *Alburnus lucidus*, 352, is a brilliant, silvery little fish, deriving its name from an Anglo-Saxon word meaning "shining." In hot summer weather it hovers a few inches below the surface of the water and glitters with silvery lustre in the sunlight as it darts after flies or any small objects floating on the surface. As in the Bream the anal fin has a long base, and the hinder part of the abdomen ends below in a sharp keel. The Bleak seldom grows to more than 4 or 5 inches in length.

Artificial Pearls.

From the scales of the Bleak is obtained a silvery powder, one of the principal constituents of which is guanin, employed in

the manufacture of artificial pearls. The process by which this glittering material is refined and utilised is said to have originated with the Chinese; the industry has been established in France for more than two hundred years. The most silvery scales are picked out and scraped, and the iridescent pigment allowed to collect at the bottom of the water as a sediment. This is placed in liquid ammonia and sold as "essence d'orient." Small glass bulbs are coated on the inner surface with this substance, and the interior filled with a hard wax. The outer surface of the glass is sometimes dulled with hydrofluoric acid to increase the illusion, and, perfectly spherical pearls being very scarce, the manufacturers of these imitation pearls even go to the length of blowing the bulbs irregular and lop-sided. Most of the "essence d'orient" is made from the scales of the Bleak, but that obtained from Whitebait is of superior quality and greater brilliance.

Loach.

In the Loaches there are from three to six pairs of barbels around the mouth; the pharyngeal teeth are in one row and in moderate number. The anterior part of the air-bladder is divided into a right and left chamber and enclosed in a bony capsule. The Loaches have a low, elongate body, with or without minute scales. They are distributed over Europe, Asia, Abyssinia, &c. They are fishes of small size, living in small streams and ponds and avoiding large rivers.

In consequence of the close connection that exists between the skin and the air-bladder, and between the air-bladder and the ear, the fishes are very sensitive to changes in temperature and pressure, and are known in parts of Germany as "Wetterfisch" or Weather-Fishes. The commonest European Loaches are the Stone Loach, *Nemachilus barbatulus*, 353; the Spined Loach, *Cobitis tænia*, 355; and the Pond Loach, *Misgurnus fossilis*, 354, the largest of the three, growing to about 10 or 11 inches.

The Spined Loach, which is scarce in Britain, may be distinguished from the other two by the presence of a small, erectile, bifid spine below the eye. The Pond Loach has 10 or 12 barbels, four of which are on the lower jaw; the Stone Loach has 6 barbels, none of which are on the mandible. The Pond Loach occurs in stagnant waters of eastern and southern Germany and

eastern Europe; it is not found in Britain. The Stone Loach occurs in Britain and on the continent, except Scandinavia; it frequents fast-running streams with stony bottom.

Cat-fishes. The family of the Siluridæ or Cat-fishes is a large one widely spread over the fresh-waters of the temperate and tropical regions; a few of the Cat-fishes are found in the sea (e. g. *Arius* (376), *Galeichthys* (377) and *Plotosus*), but they keep near the coast. They are all bottom-feeders, of carnivorous tendencies. The body has no scales, but in many genera it is armoured with bony scutes, more or less sculptured. A strong bony spine is frequently present in front of the dorsal and pectoral fins, and large bony plates occur in the skin at their bases. The spines are sometimes barbed or serrated, and constitute formidable weapons. They are not strictly comparable with the spines of Acanthopterygian fishes, such as the Perch (507, Wall-case 12) and Bass (511, Wall-case 13), since they are formed by the fusion of the pieces of a jointed fin-ray, the fusion taking place during the growth of the fish. One to four pairs of barbels usually occur around the mouth; an adipose fin is frequently present.

Wall-cases 9 and 10.

The division of the family into subfamilies and genera is based upon the extent of the dorsal fin, the presence or absence of an adipose fin, and the fusion of the lower parts of the gill-covers with the "isthmus" under the throat, or their freedom from it. In *Clarias* (359) and *Copidoglanis* (361), for instance, the dorsal and anal fins are long-based and extend to the tail-fin, whereas in the other forms shown the dorsal fin is short-based. The anal fin is long-based in *Silurus* (364), *Wallago* (367), *Silondia* (368), but not in *Amiurus* (373), *Rita* (371), &c. An adipose fin is present in the last two, and in *Doras* (379), *Synodontis* (381), &c., but is wanting in *Silurus* (364), *Silondia* (368), &c. In the Electric Cat-fish, *Malopterurus*, 386, an adipose fin is present, whereas the anterior dorsal fin supported by fin-rays is wanting.

Some Siluroids are provided with an accessory breathing organ. *Clarias* (359, and fig. 55) and *Heterobranchus* have a dendritic organ situated above the gills which enables the fish to live out of water for some time. In the dry season these fishes live in burrows in the mud and crawl out at nights in search of food. In *Sac-*

cobranchus (363) there is a long air-sac—not the air-bladder, which is also present, enclosed in a bony envelope—but a thin-walled sac extending from the first gill-slit on each side along the body as far back as the tail, and this allows the fish to exist out

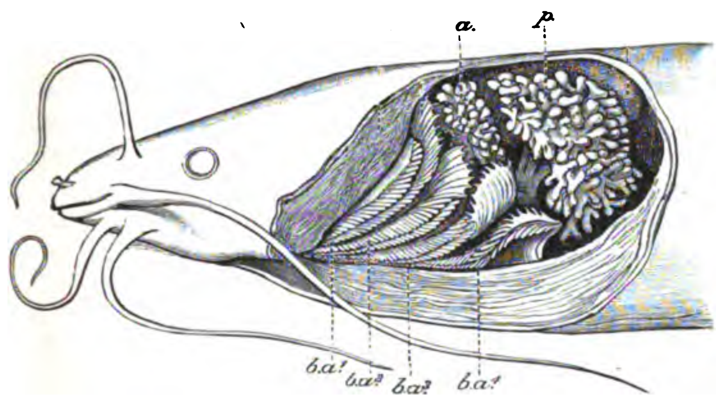

FIG. 55.—Accessory respiratory organ of *Clarias* as seen after the removal of the gill-cover: *a* and *p* the two accessory organs, ba^1–ba^4 the gills. (After Bridge, Camb. Nat. Hist., vii, 1904.)

of water for several days. The aërated blood from these air-sacs is carried back into the general circulation by means of the efferent vessels of the last gills, which join the aorta; the blood is not taken back straight to the heart. Most Siluroids can live in foul water even though not provided with accessory organs of respiration; they rise to the surface and take in air through their mouth.

The Wels, *Silurus glanis*, 364, is a fish occurring plentifully in the Danube and other fresh waters of continental Europe, but absent from France, Spain and Italy. It is said to grow to a length of ten feet and a weight of three or four hundred pounds. The male watches over the eggs and defends them from marauders, a fact which was noted by Aristotle. In the North American Bull-heads (*Amiurus*, 373) also the male guards the eggs, and defends the young after they are hatched. *Arius* (376) and *Galeichthys* (377), guard the eggs by carrying them in the capacious mouth, the male, more rarely the female, being the Wels.

custodian. The eggs of *Arius* are large, of about the size of cherries (1146, Cabinet-case 29).

Clarias (359) occurs in the muddy and marshy fresh waters of Africa and South Asia, *Copidoglanis* (361) occurs in Asia and Australia, and *Saccobranchus* (362) in the rivers of the East Indies.

Doras (379) is distinguished by a series of bony scutes along the middle of the side. It travels over land in the dry season in search of a pond of greater capacity; its progress is fairly rapid, and is effected by a springing movement of the tail, the spines of the outspread pectoral fins serving to prevent the body from rolling over sideways. These fishes make nests and both sexes tend the eggs. They occur in those rivers of tropical South America that flow into the Atlantic.

Schal.

Synodontis of the African rivers has a way of floating belly upwards at the surface of the water, a curious habit which is represented in many of the drawings of the ancient Egyptians. One of the commonest species of the Nile is the Schal, *Synodontis schal* (skeleton, 382), which grows sometimes to two feet in length.

Electric Cat-fish.

The Electric Cat-fish, *Malopterurus electricus* (383, and fig. 56), a fish not uncommon in the fresh waters of tropical Africa, has no

FIG. 56.—Electric Cat-fish, *Malopterurus electricus*.

front dorsal fin; it has a large adipose dorsal set far back, and a short-based anal fin. The skin is soft and velvety, without scales or scutes; the gill-opening is narrow, a mere slit in front of the pectoral fin. There are three pairs of barbels. The eyes are small, and the fish avoids light and is slow in its movements. The electric organ extends over the whole body beneath the skin, but is thickest on the abdomen. It consists of connective tissue compartments filled with a firm jelly; it is an organ of cutaneous

origin and is not constituted of modified muscles as is the case in the Electric Eel (315, Wall-case 8).

Callichthys (384, and fig. 57), a small fish of the rivers of the northern parts of South America, is remarkable for the cuirass which covers in the whole of the soft parts of the body. The armour consists of an upper and a lower row of large, overlapping

FIG. 57.—An armoured Cat-fish, *Callichthys littoralis*.

shields on each side, each shield being much higher than wide. The adipose fin is supported anteriorly by a short, movable spine.

In the Loricariidæ and Aspredinidæ (Wall-case 10, floor) there is a resemblance to the Siluridæ in the absence of scales, the fusion of the parietal bones with the supraoccipital, the absence of the symplectic bone, and the presence of barbels and an adipose fin, but there is a difference in the ribs being sessile upon the centra of the vertebræ and not supported on transverse processes. In the Loricariidæ the mouth is inferior, with circular lips, and feeble dentition. In the forms like *Plecostomus* (387) and *Loricaria* (386), which have a body cuirass of bony plates, the ribs are slender, but in those which have an unprotected skin the ribs are strong. The Loricariidæ are confined to tropical and sub-tropical parts of Central and South America. Many are of small size; the males of some species have a bearded or bristly snout. Loricariidæ.

In the Aspredinidæ the mouth is terminal; the head is much flattened; there are no scutes; the tail is slender. *Aspredo* (390), of the Guianas, is the largest of the genera. The female attaches the eggs to the under surface of her body by pressing upon them, when they become embedded in the skin, which is Aspredo.

soft and spongy during the breeding-season. After the breeding-season the skin again becomes smooth and firm.

ANGUILLIFORMES (Eels).

Wall-case 8, lower part.

The suborder Anguilliformes or Apodes embraces the "Eels," using the term in the widest sense. In these fishes the body is very long, and without pelvic fins (whence the name "Apodes"). The dorsal and anal fins are in a few cases wanting; in most they are long-based and continuous around the hind end of the body, there being no separate tail-fin. None of the fins have hard or "spinous" fin-rays. The vertebræ are very numerous, as one would expect in such long-bodied fishes; the shoulder-girdle is not attached to the back of the cranium and has no mesocoracoid bone. The premaxillary bones are absent, and the maxillæ are separated by the coalesced ethmoid and vomerine bones. The two parietal bones meet in a median suture; there is no separate symplectic bone.

The Eels are widely spread over the temperate and tropical zones; some occur at great depths of the sea. A few, such as the Common Eel, enter fresh water to feed and grow, but they return to the sea to breed.

Anguillidæ.

In the family Anguillidæ are included important food-fishes like the Common or Fresh-water Eel, *Anguilla vulgaris* (395), and the Conger, *Conger vulgaris* (396). In *Anguilla* there are rudimentary scales, oblong in form, deeply embedded in the skin and arranged in small groups, the scales of each group being oblique to the length of the body and at right-angles to the scales of the groups above and below. In the genus *Conger* scales are wanting.

Common Eel.

The Common Eel, *Anguilla vulgaris* (395), has a very wide distribution in the Northern hemisphere, extending through Europe, North Africa and Asia, but not occurring in the rivers discharging into the Arctic Ocean, the Black Sea and the Caspian Sea. This Eel probably also occurs in America and the West Indies, although the Americans name their common Eel *Anguilla chrisypa*. The Eel of the fresh-waters of Australia and New Zealand is of another species.

Owing to the fact that the generative organs of the Common Eel do not ripen in fresh water, numerous erroneous impressions have arisen concerniug the mode of propagation of the fish, which have only recently been dispelled. It is now definitely established that when five or six years old the Eels migrate to the sea to breed, and they do not return to fresh water. The males have been observed to precede the females, from which they may be distinguished by the sharper form of the snout; in fact, what in England are called the Sharp-nosed Eel and the Broad-nosed Eel are but the immature males and females of the same species of fish.

On their way to the breeding place, a zone of the Atlantic off the West of Ireland and France where the water is about five or six hundred fathoms deep, the skin of the fish becomes silvery and bright, the eyes large and dark, and the reproductive organs become fully developed. The Eels spawn at the great depth above mentioned, in the middle of winter, and the innumerable young hatched from the eggs grow to a length of nearly three inches, as the flat, transparent "Leptocephali."

These larvæ (fig. 58 A, p. 118) have perfectly clear, ribbon-like bodies, transparent as glass, and free from colour excepting the eyes, which are black, and are alone visible when the little fish is observed in a jar of clear sea-water. They are called Leptocephali on account of the small size of their head. The generic name "Leptocephalus" was applied to the Eel-larvæ before their history was known, and it is now merely used to distinguish a stage in the life history of various species of *Anguilla*, *Conger*, *Congromuræna*, and other "Eels." Thus, *Leptocephalus brevirostris* is the larval form of the Common Eel, *Anguilla vulgaris*; *Leptocephalus morrisii* that of the Conger Eel, *Conger vulgaris*, and so on.

The Leptocephalus developes from the egg and grows to about three inches in length, and then ceases to feed, and takes no food again until the metamorphosis is complete and the little fish has become an "Elver" (see fig. 58 D).

As the metamorphosis of the Leptocephalus into the Elver proceeds, the temporary teeth in the upper jaw are shed, and the pointed snout becomes rounded. The height of the body becomes reduced, first in the anterior and posterior parts, later in the middle

parts, so that the body becomes nearly cylindrical. In the later stages the length also diminishes. Pigment is developed in the skin, and the eyes become slightly reduced during the metamorphosis.

During the later stages of the metamorphosis the little fish become very active, and they swim in enormous numbers in an

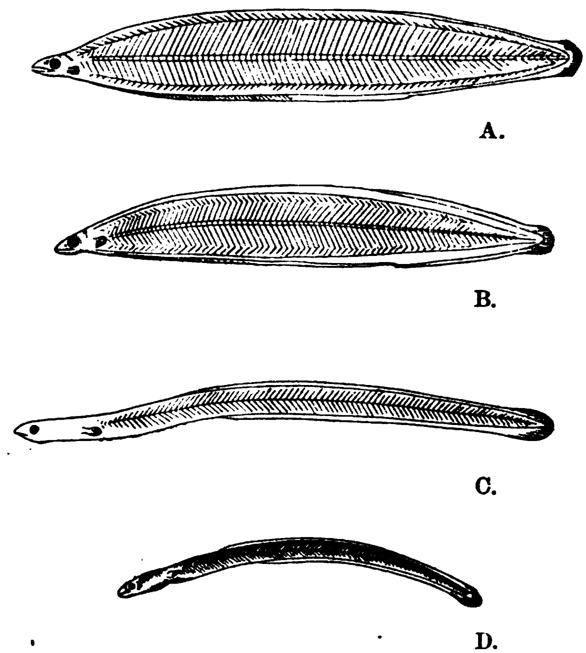

FIG. 58.—Metamorphosis of the Common Eel, *Anguilla vulgaris.*

A. The larva, known as *Leptocephalus brevirostris.*
B. Later stage, the metamorphosis commencing.
C. Transition stage; Glass Elver.
D. Elver, from fresh water, the metamorphosis complete.

All of the figures are of the natural size.

easterly direction, arriving at the mouths of the western rivers of Ireland, England and France in the spring. While in the sea they are still colourless, and are known as "Glass Elvers," but as they get into fresh water they develop pigment in the skin, and then are "Elvers" (see fig. 58 C and D).

The Elvers ascend our rivers in millions; some climb the banks of the rivers and streams and pass over wet fields, eventually reaching suitable ponds; others stay in holes in the muddy banks of the streams. The Elvers are greatly reduced in numbers as the migration proceeds, many being eaten by fish such as the Pike, and by birds, while for human consumption vast quantities are caught and sold during the "Eel-fare," as the migration of the Elvers is termed.

There are no reliable statistics of the British Eel-fisheries; in Denmark they are important and produce an annual yield of over £100,000 in value. Eels are caught usually in traps of basket-work or netting, especially during their migrations to thé Atlantic in autumn for the purpose of spawning.

Eels are voracious feeders and diligently poke their noses under small and large stones, and laboriously move the large ones, sometimes assisting one another in their search for crustaceans, fishes, spawn, &c., upon which they feed. They are extremely rapid in their movements, and when well grown have few enemies but man; the Pike, however, commits great depredations among the young ones.

Eels grow naturally to about three feet. If prevented from descending to the sea they grow to four feet or more, and one specimen has been known to live to the age of forty years in fresh water. The Eel is an excellent food-fish, the flesh being of agreeable flavour, and tender if properly cooked, although becoming tough and leathery in inexperienced hands.

The Conger (396) is a purely marine fish, and prefers deep waters with a rocky bottom. It is almost cosmopolitan and is widely distributed along the coasts of the North Atlantic, Mediterranean, Japan, Tasmania, &c. It is caught on long-lines, and in the British Isles the fishery yields about 70,000 cwts. annually, valued at nearly £50,000. The Conger is a coarser fish than the Anguilla and grows to a larger size, the female sometimes attaining a length of eight feet; the male rarely exceeds two feet. A Conger may be readily distinguished from a Common Eel by the dorsal fin commencing nearer the head than in the latter. Conger.

The Nemichthyidæ differ from the Anguillidæ in the vent being set forward, close to the gill-openings; the gill-openings are wide, Nemichthyidæ.

and nearly confluent. The eyes are large. The fin-membrane between the rays of the dorsal and anal fins is thin, and in some genera, like *Nemichthys* (398), the jaws are remarkably long and feeble, forming a slender beak or bill. The Nemichthyidæ are deep-sea fishes found in the great oceans of the world, and do not attain any great size.

Sacco-pharyng-idæ.

The Saccopharyngidæ, known in America as "Gulpers," are very grotesque fishes of the deep seas, more or less allied to the Eels (see fig. 6, p. 18). The mouth is very large, and the stomach is extremely distensible and capable of accommodating prey of larger size than the fish itself. The eyes are small and set far forward, the tail is long and slender, ending in a filament. The skeleton is imperfectly calcified. Examples of *Saccopharynx* (986) and *Gastrostomus* (985) are shown in the case of "Deep-sea Fishes," Cabinet-case 44.

Muræ-nidæ.

In the Murænidæ or Morays the branchial openings into the pharynx are narrow slits, whereas they are wide slits in the

FIG. 59.—Moray, *Muræna helena.*

Anguillidæ; the external gill-opening on each side is small and round. The skin is without scales. The pectoral fins are usually wanting and in some cases the pectoral arch also.

The Murænas are voracious fishes of tropical and subtropical seas and do not hesitate to attack man; they are especially abundant in the vicinity of coral reefs. Many are of large size,

reaching a length of eight or ten feet, and most are of remarkably rich and varied coloration.

Muræna helena, the "Muræna" of the Romans (fig. 59), is largely used as food around the Mediterranean. The species can be domesticated and will live in fresh water. The fishes were extensively kept by the Romans and fattened in special tanks and ponds, and according to certain traditions were fed with the bodies of slaves. The fish is not confined to the Mediterranean, but occurs also in the north-western part of the Indian Ocean, the eastern part of the Atlantic, and is sometimes caught off the coast of England.

Esociformes (Pikes).

In the suborder Esociformes or Haplomi, including the Pikes and their allies, the anterior vertebræ are without Weberian ossicles, and the shoulder-girdle is connected with the back of the skull. The two parietal bones are usually separated by the supraoccipital. The fins are usually without spines, but the first ray of the dorsal fin is sometimes stiffened and spine-like. There are no barbels. The pelvic fins are abdominal in position. These fishes occur chiefly in fresh water, but some in the deep sea. Wall-case 10.

The Galaxiidæ are a small family of scaleless fishes in which the parietal bones meet in the middle line of the skull, the post-temporal bone is not forked, and the ribs are attached to strong transverse processes. The chief genus is *Galaxias* (406), occurring in the fresh waters, and in some cases also the seas, of the southern parts of the world, South Australia, New Zealand, the south of South America and the Cape of Good Hope. The settlers in New Zealand called these fishes "Trout" and the young "Whitebait," and the names still survive to a certain extent. The native name of the fish is "Kokopu." Galaxiidæ.

The Esocidæ constitute a small family of carnivorous fresh-water fishes including the Pikes and the Umbras or Mud-Minnows, and ranging through the temperate parts of the northern hemisphere. The upper border of the mouth is supported by the maxillary as well as by the premaxillary bones, but the former are toothless. There are no transverse processes to the trunk vertebræ; the Esocidæ.

post-temporal bone is forked. The dorsal and anal fins are set far back; the pectoral fins are set low down the sides of the body; the pelvic fins have 6–11 rays. The body is clothed with cycloid scales.

Pike. The Pike, *Esox lucius*, 407, so well known to sportsmen of the rod, hardly requires description. It is limited to fresh water and ranges through Europe, Asia and America. The Pike is an extremely voracious fish, and so great is the havoc wrought by it among more valuable fish, such as the Trout, that in certain districts special measures have to be taken to keep down their numbers. The head is long, broad and flattened, the body is long and somewhat laterally compressed, and the sides themselves are much flattened. The dentition is powerful, and the teeth being sharp, closely set, and with the points directed back towards the throat, there is little chance for the prey to escape when once in contact with the teeth. How efficacious is the dentition is known to all fishermen who in attempting to remove the hook from a large dead fish have had the uncomfortable experience of getting part or the whole of the hand within the mouth. Every movement of the hand causes it to get carried farther and farther into the throat.

The colour of the Pike varies considerably with the seasons. The back is always dark olive, the sides are grey and green with a slight silvery lustre, except at the breeding season, when the colours of both sexes become darker and more vivid. The Pike is a solitary fish, except during the pairing season, and punishes the intrusion of smaller individuals of its own species within its haunts by devouring them. Its food consists of all kinds of fish, frogs, ducklings, the young of water-fowl, &c. The Pike is a strategist in pursuing its prey. It remains perfectly still and rigid, or advances quietly and stealthily, and then by a powerful movement darts forward, and the fish or bird that it was stalking is within its jaws.

The Pike is not commonly eaten, although by some the flesh is considered as not unpleasant. A definite standard of size for a full-grown Pike can hardly be assigned, since the fish continues to enlarge so long as it can get food and avoid its enemies; neither is it known with certainty to what age Pike will live. The specimen exhibited (407) would rank as a good large fish; when

caught it weighed 30 lbs. and measured 48 inches in length and 23 inches in girth. Pike under 4 lbs. are usually called "Jack."

Umbra.

The Umbras or Mud-minnows include one species (*Umbra crameri*) which occurs in Hungary and the countries around, and two others (*Umbra limi*, 409, and *Umbra pygæma*) which are inhabitants of the eastern slope of the American continent and the Mississippi valley. The jaws are not produced as they are in the Pikes, and the teeth are all small. The dorsal fin is set more forward than in the Pikes and the scales are relatively larger. The Umbras frequent still waters and are most at home in muddy and reedy ponds; when startled they burrow tail foremost into the mud. They are small, sluggish and carnivorous.

Scopelidæ.

The family Scopelidæ is a fairly large one, comprising pelagic and deep-sea fishes and some extinct forms from the Cretaceous and Tertiary deposits. The premaxillary bones are long, and exclude the maxillæ from sharing in the support of the upper border of the mouth; the parietal bones are separated; there are no transverse processes to the vertebræ; the post-temporal is forked. An adipose dorsal fin is frequently present, and in the deep-sea forms luminous areas (photophores) occur in the skin of the body and head.

Scopelus (413) is a genus with many species, mostly of small size, with large eyes and with photophores. While some are confined to the depths of the sea others are pelagic, and others again remain in deep water during the day and come to the surface at night. Many of the species occur in the Mediterranean, others in the Atlantic and Pacific Oceans. In the Case of Deep-sea Fishes (Cabinet-case 44) are shown two curious forms belonging to this family. *Bathypterois* (983) is a small-eyed fish, first obtained by the "Challenger," remarkable for the great elongation of the uppermost rays of the pectoral fins, which are forwardly directed and act as "feelers." The foremost rays of the pelvic fins are also elongated, though not to the same extent as those of the pectoral, and by these doubtless the fish feels its way along the bottom of the sea. *Ipnops* (976) is a still more remarkable fish, dredged by the "Challenger" from 1600–2000 fathoms, with no eyes, but

with two luminous patches nearly touching one another on the top of the broad, flat head. The photophores are supposed to attract small fishes as a candle or gas flame attracts moths, and the *Ipnops* having lured such prey into the neighbourhood of its large mouth does not need eyes to see what that prey is before gulping it down.

Bummalow. The Bummalow or Bummaloe, *Harpodon nehereus*, 412, is a uniformly phosphorescent fish, frequently found in great numbers at the surface of the Indian Ocean and even in the estuaries of the coast of Bengal and Burmah. After salting and drying, these fishes are exported in large quantities from Bombay and the Malabar coast and sold under the name of "Bombay Duck," a delicacy familiar to all who have travelled in India.

Aulopus purpurissatus, 414, the "Sergeant Baker" of the Australian fishermen, occurs in moderate depths of the sea off the coast of Australia. It has a small adipose fin, rough, firm scales, and no luminous spots.

Alepidosaurus. The Alepidosauridæ are deep-sea fishes differing from the Scopelidæ in the great size of the dorsal fin, which is supported by long, slender, unjointed fin-rays. An adipose fin is present. The body is without scales; the teeth are formidable; the bones are feebly ossified. These fishes are found in the Atlantic and Pacific Oceans, and include the largest of the deep-sea fishes, some attaining a length of four feet. The skull of *Alepidosaurus ferox* exhibited (415) shows the great predatory teeth and the frailness of the bones; a complete skeleton (1097) in a special glass case is shown elsewhere in the Gallery.

Killie-fishes. The Cyprinodonts (e. g. 416) are small fishes occurring in fresh or brackish waters of America (where they are known as Killie-fishes), and in Africa, Southern Europe, and Southern Asia. The head is rather flattened, the mouth is extremely protractile and with the upper border supported by the premaxillaries only. The scales are large and extend more or less over the head. A few Cyprinodonts are herbivorous and have a long intestine, but most are carnivorous and with a short intestine. The females are usually larger than the males and not so brightly coloured, and in many species they are viviparous.

One of the most curious of these fishes is the *Anableps*, or Four-eyed Fish, *Anableps tetrophthalmus*, 417, of the fresh waters of tropical America. This fish has not really four eyes, but its eyes, which bulge considerably, are divided into an upper and a lower portion in such a manner that the fish as it swims at the surface of the water can see both in and out of that medium, the upper part of the eye being adapted for use in air and the lower part for use in water. There is nothing exceptional in the general appearance of the large crystalline lens and the retina, but the iris is curiously altered so as to present two pupils, one above the other. This is effected by a pair of overlapping horizontal flaps of the iris passing across the middle of the originally simple pupil. Four-eyed Fish.

The Amblyopsidæ are small fishes related to the Cyprinodontidæ. They are confined to North America; some live in streams and ditches and have eyes, others occur in subterranean waters of the great limestone caves. These last are blind, the eyes being vestigial and hidden under the skin. The body is colourless and transparent. One of the best known is *Amblyopsis spelæa* (418), the Cave-fish or Blind-fish of the Mammoth Cave of Kentucky. By way of compensation for the loss of vision the sense of hearing is very acute, as also is the tactile sense, there being developed on the head numerous transverse ridges with papillæ, which judging from their abundant nerve supply are delicate organs of touch. The largest specimen known is five inches long. The fish is viviparous, and the young are about a quarter of an inch long when born. Cave-fish.

Physoclisti.

In the grade Physoclisti the air-bladder, although developing as a hollow outgrowth of the alimentary canal, becomes shut off from it by the disappearance of the neck or tube, the "ductus pneumaticus." Some of the Berycoid fishes (Wall-case 12), the most primitive of the Acanthopterygian fishes, are exceptional in this respect. The great majority of the Teleostean fishes belong to the grade Physoclisti; the exhibited series extends from the middle of Wall-case 10 along the North and East Walls to the other end of the Gallery (Wall-case 20). Wall-case 10.

Halosauriformes.

The Halosauriformes or Heteromi constitute a small suborder of fishes, mostly confined to the deep seas. The pelvic fins, if present, have many fin-rays (about 10) and are set far back (abdominal position); the pectoral fins are set high up the sides of the body; the right and left parietal bones meet. The mesocoracoid bone in the shoulder-girdle is reduced or absent; the post-temporal bone is small and simple. The suborder includes the families Halosauridæ, Notacanthidæ, Dercetidæ (extinct; Cretaceous), and Fierasferidæ.

The Halosauridæ and Notacanthidæ are long-bodied, deep-sea fishes, with tail tapering to a point and without a separate caudal fin. The body is clothed with cycloid scales, which extend also partly over the head. In the latter family (e. g. *Notocanthus*, 420) the dorsal fin is represented by a series of short, isolated spines; the anal fin is long, the front part supported by spines, the hinder part by soft rays. In the Halosauridæ (e. g. 419) there are no spines; the dorsal fin has a short base, the anal a long base.

Fierasfer. *Fierasfer* (421) is a strange little fish which lives in the bodies of holothurians, starfishes and bivalve molluscs, particularly the Pearl Oyster. It is not a parasite, so far as our present information goes, but catches its own food from the sea water, and enters and leaves the body of its host repeatedly without apparently causing any inconvenience. *Fierasfer* is found near the coast in all warm and tropical seas. It has a long tail, with extended dorsal and anal fins reaching to the extremity, which has no separate caudal fin. The anus is far forward, in the throat region; there are no scales and no pelvic fins.

Gastrosteiformes (Sticklebacks and Sea-horses).

The suborder Gastrosteiformes or Catosteomi includes curious fishes, the affinities of which have been the object of much discussion. The least aberrant forms are the Sticklebacks, with

which the Pipe-fishes and Sea-horses are related, in spite of their strangely modified gills (see fig. 61, p. 131). The Opah or King-fish, though so different in appearance from the Sticklebacks, would seem to be more closely allied to these than to any other fishes.

The family Lamprididæ, constituting the division Selenichthyes of some authors, contains only the fish just mentioned, the Opah, *Lampris luna*, Floor-case 27. This is a large fish, attaining sometimes the length of four feet. The body is short and deep, and laterally compressed; it is covered with minute scales; the snout is short and the mouth toothless. The branchial apparatus is fully developed, and the gills are of the ordinary pectinate type. The fins are without spines. The pelvic fins have numerous rays (15–17), and the pelvic bones are connected with the coracoid bones, which are large and do not meet ventrally. The coloration of the Opah is vivid, and the flesh is considered choice. The fish is pelagic in habit and is widely distributed, specimens having been taken in various parts of the Pacific and North Atlantic Oceans, the Mediterranean, and off the coast of England. **Opah.**

The Sticklebacks (family Gastrosteidæ) are small fishes, with the dorsal fins armed with two or more spines and with the sides of the body more or less protected by bony shields instead of scales. The pelvic fins are abdominal in position; each has one spine and one or two soft rays; the pectoral fin has no spine, the anal fin has a single spine. The mouth is toothed; the ribs are slender; the anterior vertebræ are not enlarged or only slightly elongated. **Stickle-back.**

The Sticklebacks are widely distributed over the northern seas and fresh waters. Several are British. This family is by some authorities grouped with the Centriscidæ, Amphisilidæ, Aulostomatidæ and Fistulariidæ to constitute the division Hemibranchii, characterised by the possession of pectinate gills, more or less reduced in number, with a complete opercular apparatus; with a small and terminal mouth and the post-temporal bone simple and immovable.

The common Stickleback of England (424) is *Gastrosteus aculeatus*, called also the Three-spined Stickleback from the fact

that at the front of the dorsal fin are three short spines. It is very abundant in all fresh waters, and can be transferred to brackish and sea water without injurious effect. The fish occurs in three varieties; var. *gymnurus*, the smooth-tailed variety, with from four to six bony plates behind the gill-cover; var. *semiarmatus*, the half-armed variety, with from ten to fifteen bony plates behind the gill-cover and a few blunt spines on the side of the base of the tail; and var. *trachurus*, the rough-tailed variety, with an uninterrupted series of from thirty to forty bony plates along the side of the body. From recent observations it appears that the variety *trachurus* is a winter form, the variety *gymnurus* the same fish in summer dress, when it has discarded its armour, and the variety *semiarmatus* a fish caught in the spring. In the case of the American *Gastrosteus cataphractus* the individuals caught in the sea have a complete armour of bony plates, about thirty on each side; those found in brackish water are half-armoured, with from six to twenty plates, while those found in fresh water have only two or three plates or even none at all.

The common Stickleback is an active, persistent and greedy little fish. It is very pugnacious and protracted fights are not uncommon; after the fight the colour of the defeated combatant at once becomes dull, while that of the victor remains resplendent. It is no unusual thing also to see a group of Sticklebacks worrying a fish much larger than themselves by biting little pieces out of the margin of the fins. Sticklebacks do much mischief by devouring the spawn and fry of other fishes.

In the breeding-season the throat and breast become brilliantly red, particularly so in the males. The male builds a nest by collecting bits of water-weed and leaf-skeletons and cementing them together with a glairy fluid which is secreted in glands opening at the urino-genital aperture, and which hardens into tough threads in contact with water (compare the byssal threads of the bivalve molluscs *Pinna* and *Mytilus*, the common Mussel). The nest is constructed prior to mating. A female is then induced to enter the nest and lay her eggs, and when she departs through the other opening, for there are two, one at each end, the male enters and fertilises the eggs. The process is then

repeated with other females in succession, and finally the male takes up his position outside the nest and jealously guards it it against all comers until the young Sticklebacks are hatched. Oddly enough, the most persistent assailants are the mothers themselves, who seek to devour the eggs.

The Ten-spined Stickleback, *Gastrosteus pungitius*, 425, is not so common as the Three-spined Stickleback; it has nine short spines on the back and a longer tenth. The Fifteen-spined Stickleback, *Spinachia vulgaris*, 426, is a marine form, common in rock pools around the British and other coasts of Europe.

Flute-mouth.

The Flute-mouth or Tobacco-pipe-fish, *Fistularia tabaccaria*, 428, has a long, slender body, with the snout produced into a long tube, which has the mouth, small and toothless, situated at the end. The first four vertebræ are much elongated and are fused together; the supratemporal bones are much produced posteriorly. There are no spines in the fins, and no scales, but bony plates, in the skin. There is a distinct caudal fin, which is forked and has the median fin-rays produced into a filament. The fish swims near the surface in shallow seas of the tropical and sub-tropical regions of the globe.

The Aulostomatidæ (427) bear a general resemblance to the Fistulariidæ, but differ in the following respects:—there are spines in front of the dorsal fin, the caudal fin is rhombic, and without the elongated central fin-rays, there are small, ctenoid scales in the skin and small teeth in the jaws.

Snipe-fish.

In the Snipe-fishes (family Centriscidæ, e.g. 430) the body is laterally compressed and deep vertically; the snout is in the form of a tube, with the small toothless mouth at its extremity; some of the anterior vertebræ are elongated; the front part of the dorsal fin has a few spines, one much larger than the others; the anal fin has no spines. Scales are present, also bony scutes dorsally and ventrally, forming an incomplete bony armour which is distinct from the vertebræ. The Common Snipe-fish is widely distributed in warm seas, and is sometimes found off the south coast of England.

Amphisile.

The Amphisile (432), sometimes called the Needle-fish or Shrimp-fish, is a curious, semi-transparent little fish, which carries the body with the long axis upright, and cleaves the

water with its sharp ventral edge. The body is protected by a dermal cuirass which is continuous with the internal skeleton; there are about six large, elongated trunk vertebræ and fourteen very small caudal. The body ends in the two dorsal fins, the first of which bears a strong spine; the tail fin is reduced and is ventral, not terminal in position.

Pipe-fishes and Sea-horses.

The families Solenostomatidæ and Syngnathidæ agree in having gills which are not comb-like, but reduced to small rounded knobs or lobes borne by the gill-arches (fig. 61); they were formerly grouped in a special division known as the Lophobranchii. Not only are the gills reduced but the gill-cover also; there is no preopercular bone and only a few branchiostegal rays. The skin is strengthened by large, star-shaped, bony plates or by bony rings encircling the body; there are no scales. The muscular system is feebly developed. The snout is prolonged into a tube, and the mouth is small, terminal and toothless.

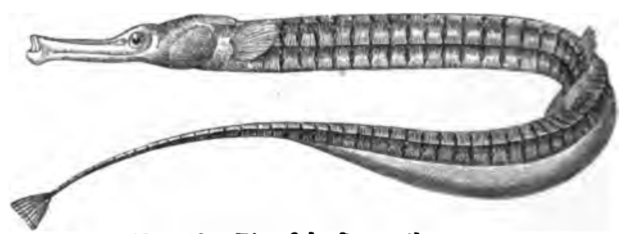

FIG. 60.—Pipe-fish, *Syngnathus acus.*

In the Syngnathidæ the gill-opening is small and set high up; the anterior dorsal fin and the pelvic fins are wanting. The eggs are carried by the male in a brood-pouch situated either on the abdomen or on the tail, and usually formed by two folds of skin, right and left. In *Nerophis* (434) and *Gastrotokeus* (437), however, there is no pouch; the eggs are embedded in the soft skin of the abdomen of the male. The Syngnathidæ are small and marine, living near the coast in temperate and tropical regions; they are poor swimmers and are carried about passively by currents.

The commonest forms are the Pipe-fishes (e. g. the Greater Pipe-fish, *Syngnathus acus,* 436, and fig. 60, the Ocean Pipe-fish, *Nerophis æquoreus,* 434), which have a tail that is not prehensile.

Solenognathus (438), of the seas of China and Australia, has a short prehensile tail by which it holds on to pieces of sea-weed among which it lives. The Sea-horse, *Hippocampus abdominalis* (440, and fig. 61) has a well-developed prehensile tail, and carries the body in a vertical position. The head is bent at right angles to the body and bears some resemblance to the head of a horse; it is very like the "knight" of the chess-board. In the Dragon-fish, *Phyllopteryx*, 439, the tubercles or spines are produced into large, soft, leafy streamers, composed of skin, and bearing a close resemblance to bits of sea-weed.

The fishes of the family Solenostomatidæ (433) differ from those of the Syngnathidæ in having large pelvic fins and an

FIG. 61.—Lobular gill of Sea-horse, *Hippocampus abdominalis*, brought into view by turning the gill-cover forward. (From Günther, "Study of Fishes.")

anterior, spinous dorsal fin, and in the gill-opening being wide. The brood-pouch is constituted by the broad pelvic fins, and occurs in the female.

The Pegasus, *Pegasus volitans*, 443, is an odd little fish found on the sandy shoals of the coasts of Japan, China, India, and Australia. The mouth is on the under side of the head and has no teeth; the gills are pectinate, and not lobular as in the Sea-horses. The body is entirely covered with bony plates, arranged in the form of rings. The pectoral fins are broad and horizontal, like large wings; in the species in question the five front rays have the form of strong spines. These fishes constitute the division Hypostomides. The dried bodies of the Pegasus are frequently used by the Chinese in conjunction with shells Pegasus.

and bits of red coral in the ornamentation of fancy boxes, many of which are brought to England by sailors and travellers as curios.

Mugiliformes (Grey Mullets).

Wall-case 11. The suborder Mugiliformes or Percesoces includes the Sand-eels, Grey Mullets and Barracudas, and occupies an intermediate position between the Pikes on the one hand and the Perches on the other. The pelvic fins, if present, are abdominal in position, and consist usually of one spine and five soft rays. The pelvic bones are not firmly connected with the shoulder girdle. The shoulder girdle is suspended from the cranium, and has no mesocoracoid bone. The supraoccipital bone extends forwards between the reduced parietal bones.

Skipper. The first family, the Scombresocidæ, takes its name from *Scombresox*, the Skipper, 451, also known as the Saury, a fish sometimes caught off Britain, and reminiscent of the Mackerels in the possession of a few finlets behind the dorsal and anal fins. The Skippers swim at the surface in large shoals and are pursued by the Tunny and Bonito as well as by Porpoises. Although their fins are small, they are very rapid in their movements, and the fishes spring out of the water and glide along the surface appearing scarcely to touch the water.

Gar-fish. The Gar-fish, *Belone vulgaris*, 449, of the coasts of Britain, France and the Mediterranean, is less pelagic than the Skipper, and has not the finlets; it is very voracious, and the larger species, not found in British waters, are dangerous to man, not so much from the injury inflicted by the teeth as from the ugly wound that they can make by driving the closed beak into the flesh, as they sometimes do when leaping out of the fisherman's net at the side of the boat. Although the Gar-fish is good eating, it is disliked by many people on account of the green colour of its bones. There is a well-founded prejudice against green pigments other than the green colouring matter (chlorophyll) of leaves and fruits, but it so happens that the green substance in the bones of the Gar-fish is not poisonous. A similar green coloration of the bones is found in the Protopterus or African Lung-fish (Wall-case 6).

The Half-beak, *Hemirhamphus*, 450, of most tropical seas, instead of having the upper and lower jaws both prolonged to form a beak, has only the lower jaw long. It feeds mostly on green seaweeds. Half-beak.

The Flying-fishes, *Exocœtus* (452, and fig. 62) do not have the jaws prolonged; the teeth are feeble and uniform, the pectoral fins, Flying-fish.

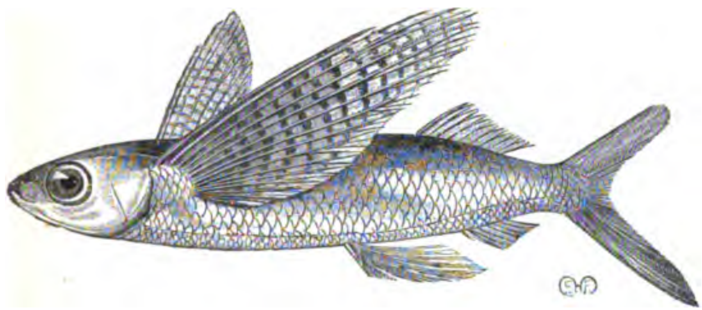

FIG. 62.—A Flying-fish, *Exocœtus spilopterus.*

and in some species the pelvic fins also, and the lower lobe of the tail are greatly enlarged. They live in shoals in tropical and sub-tropical seas and are pursued by large fishes such as the Tunny and Albacore. *Exocœtus volitans* is a small species, with short pelvic fins, sometimes taken off the British coast; the largest Flying-fish is the Californian species, which attains a length of eighteen inches.

Although called Flying-fish, the species of *Exocœtus* do not really fly. They leave the water with great velocity by a powerful movement of the tail, and then scud through the air until they reach the water again, when another rapid movement of the tail may start them afresh through the air without the whole of the body entering the water. The pectoral fins are not moved as organs of true flight. They may vibrate and quiver somewhat, but the whole motive power is supplied by the strong tail. The movements of the pectoral fins are in no way comparable with these of the wings of a bird; the fins act as a parachute only.

The Sand-eels or Launces (family Ammodytidæ) are small, silvery fishes swimming in shoals near the shore, and remarkable for the manner in which by their sharp pointed snout they bury Sand-eel.

themselves with great rapidity in the sand, darting in and out like arrows. Sometimes the falling tide leaves a sandy stretch of beach looking like a moving foam of silver through the Launces dodging and wriggling in and out of the wet sand. Both dorsal and anal fins are extended (fig. 63) and without spines. There are no pelvic fins. Two species occur on the British coast, the Greater Launce or Greater Sand-eel, *Ammodytes lanceolatus*, 455, and fig. 63, growing to seventeen inches, and the Lesser Launce or Lesser

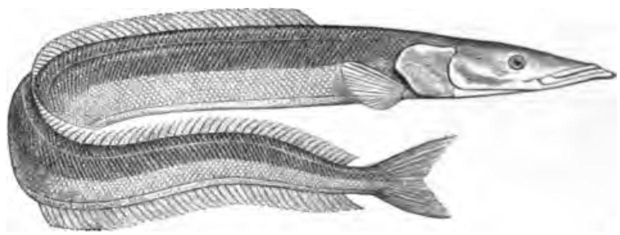

FIG. 63.—Sand-eel, *Ammodytes lanceolatus*.

Sand-eel, *Ammodytes tobianus*, 454, which grows to seven inches, has flatter sides than the Greater Launce, and lives higher up the sandy shoal. They are not much eaten but make excellent bait.

Sand-smelt.

The Atherines or Sand-smelts are small fishes rarely exceeding nine inches in length, of a translucent pale green colour, and with a silvery band along the side. They are littoral fishes, living in shoals in the seas of the temperate and tropical regions of the globe, but some species enter or live entirely in fresh water. *Atherina presbyter*, the Common Sand-smelt, 456, is not uncommon on the British coasts. It is sometimes mistaken for the Smelt, which is a Salmonoid fish (294, Wall-case 7), but the uninitiated can at once tell the Atherine from the true Smelt by the presence of spines in the front dorsal fin. The Sand-smelts are highly esteemed as food; the celebrated 'Pesce Rey' of Chili is a species of *Atherina*.

Grey Mullet.

The Grey Mullets (family Mugilidæ) are robust-looking fishes with broad, blunt head and small, nearly toothless mouth. The scales are cycloid, of moderate size and arranged in regular rows; the first dorsal fin is small and has few spines (usually four) and the pectoral fins are inserted high up. The second portion of the stomach is thick and muscular like the gizzard of a bird, and the

intestine is long and much convoluted. The fishes live on the small organisms contained in the mud and sand; they feed in large parties or schools on the bottom in quiet water with the head downward; the food is sifted in the mouth and the mud and sand rejected. The exhibited specimen of Grey Mullet, ***Mugil capito***, **457**, is the commonest of the three species found off the British coasts. All Grey Mullets are valued as food, those taken from fresh water particularly so.

In Honolulu they havé a very ingenious plan of rearing the Grey Mullet in Mullet-ponds. Across an arm of the sea is built a stone wall with very numerous small openings between the stones. Through these openings the young Mullets enter, and they rapidly fatten on the abundant algàl and other vegetation of the creek, and become too big to get back through the holes to the open sea. The plan is not without its drawbacks, however, for young Barracudas (*Sphyræna*, e. g. 460) enter the creek through the stone wall in pursuit of the young Mullet and, when inside, feed on the Mullet, and grow too large to get out again.

The Polynemidæ or Thread-fins (459) are allied to the Grey Mullets. Like them they are of a bluish silvery colour; their eyes are covered with a filmy skin; the scales, however, are more or less ctenoid, and the lowest fin-rays of the pectoral fin are separated by an interval from the rest of the fin and consist of long free filaments, which are organs of touch, and can be moved independently of the functioning fins themselves. In some the filaments are twice as long as the body of the fish. The possession of these tactile filaments is connected with the partiality of the fishes for turbid water. Some of the fishes of this family grow to a length of four feet. From the air-bladder of some of the Indian species a good quality of isinglass is obtained (1186, Cabinet-case 28). Thread-fin.

The Chiasmodontidæ, which are represented in the exhibited series by *Chiasmodon nigrum* (978, Cabinet-case 44, and fig. 7, p. 18), are fishes of the depths of the mid-Atlantic, with soft flesh and feeble spines, reduced scales and reduced gill-covers. The dentition is powerful, and some of the front teeth are more or less hinged, so as to be capable of being bent back towards the throat. Of the few specimens known most have been found floating dead on the Chiasmodon.

surface of the ocean, with the body highly distended by a fish as large as or even larger than the *Chiasmodon* itself, so that the latter appears to be spread out over the top of a bag containing the swallowed fish. The explanation offered is that the *Chiasmodon* is extremely voracious and will attack a fish as large as itself. When so large a prey has been swallowed, decomposition proceeds faster than digestion, and the gases generated cause the fish to rise out of its normal depth in the ocean, and as it rises through successively higher strata the gases expand and carry the body upwards more rapidly than before, and so the fish comes to float at the surface, dead.

Barracuda. The Sphyrænidæ or Barracudas are long, slender, swift and voracious fishes, with powerful teeth, developed in sockets. They are found in nearly all seas of the temperate and tropical regions, often also in estuaries. Some of the tropical species, such as *Sphyræna agam* (460), *Sphyræna obtusirostris* (462, skull, showing teeth in sockets), and *Sphyræna commersonii* (1019, Table-case 39, 5 ft. 1 in. long), grow to six feet and are dangerous to persons bathing, more so than sharks because less readily frightened away. They will even make savage bites at the paddles of a canoe. The anterior dorsal fin is supported by spines and is well separated from the second or soft dorsal; the anal fin is opposed to the latter; the scales are cycloid and in regular series; there is no muscular gizzard such as occurs in the Mullets. The flesh of the Barracuda is good, but it is poisonous at certain seasons, particularly in the West Indies.

Stromateidæ. The Stromateidæ (e.g. 464) are a group of small fishes with short, compressed bodies, smooth, small scales, regular in arrangement, and usually extending over the cheek and bases of the median fins. The dorsal and anal fins are much extended, each with a few, feeble, crowded spines in the front portion. The number of vertebræ is unusually large, the jaws and teeth are feeble. The most distinctive feature of the Stromateidæ is the possession by the œsophagus of a pair of lateral sacs, the interior of which is beset with papillæ bearing small teeth. The young swim freely near the surface of the open ocean, feeding on pelagic crustaceans and the fry of fish, the adults, in many cases at least, are inhabitants of the deep sea. The Black-fish or Black Ruff,

Centrolophus niger, 465, of European seas is occasionally, but rarely, caught off Britain, as also is the Rudder-fish, *Lirus perciformis*. *Stromateus fiatola*, 464, the 'Fiatola' of the Italian fishermen, is an excellent food-fish of the Mediterranean. *Nomeus gronovii*, 466, a little fish about three inches long, widely distributed and common in the Gulf of Mexico, is found sheltering from its enemies among the long streamers of the Portuguese Man-of-War (*Physalia*), from which it enjoys a remarkable immunity. As many as ten of these fishes may be found swimming about beneath a large *Physalia*.

Tetragonurus.

The remarkable deep-sea fish *Tetragonurus* (463) is allied to the Stromateidæ, as is shown by the structure of the mouth, the dentition, and more particularly the occurrence on each side of the œsophagus of a muscular sac studded internally with rather soft papillæ. There is but a single species, *Tetragonurus cuvieri*, sometimes called the Square-tail. It occurs in the Atlantic, Mediterranean, and the South Pacific, but is rare; it is poisonous as food; it feeds on jelly-fish, and probably lives in the depths of the sea by day and comes to the surface at night to feed. The young are said to live in the pharyngeal cavity of large Salps.

Climbing Perch.

The Climbing Perch, *Anabas scandens*, 468, is so called because it is able to climb a sloping bank, to travel over land, and, it has been stated, to climb trees, by means of the stout, backwardly sloping spines of the anal and pelvic fins and of the gill-cover, which is very movable. The fish holds on to the ground by the opercular spines, bends its tail and inserts its anal spines; it then straightens the body and causes the opercular spines to move forward over the ground, and then repeats the whole operation. The fish wriggles along thus on its side at a fairly rapid rate. The Climbing Perch can live a long time out of water; above the gills are a pair of large cavities, opening downwards, and divided up by thin, scroll-like plates of bone covered with delicate and highly vascular mucous membrane, by which air is breathed. The air is taken in through the mouth, and is expired through the mouth, not through the gill-openings. The Climbing Perch is a freshwater fish of India, Burmah and Malay; some species of *Anabas* occur in Africa.

Snake-head.

The Snake-head, *Ophiocephalus striatus*, 467, of the grassy swamps of China, India and the Philippine Islands, resembles

Anabas in its ability to survive long drought. It has an accessory suprabranchial cavity for aerial respiration, but the cavity is not filled up by a scroll-like labyrinthic organ as it is in the Climbing Perch. The Snake-head differs from *Anabas* also in having cycloid instead of ctenoid scales, and in having no spines to the fins. It has been naturalised in western North America, where it is known as the China-fish, the parental forms having been introduced from China.

Gadiformes (Cod-fishes, &c.).

Gadiformes. Wall-case 11.

Included in the suborder Gadiformes are the Cod and its allies, and the Macrurid fishes. The pelvic fins, if present, are set far forward, either below or in front of the pectorals. There are no spinous fin-rays in any of the fins (except the first dorsal fin-ray of some Macrurid fishes). The tail-fin is symmetrical, the vertebral axis is not uptilted. The parietal bones are reduced and are separated by the supraoccipital; the pro-otic and exoccipital bones are separated by the opisthotic, which is large.

Macrurus.

The Macruridæ (e. g. *Macrurus*, 472, and fig. 64), called in America Rat-tails or Grenadiers, are entirely confined to the deeper

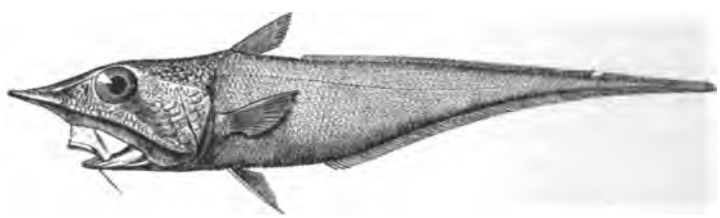

Fig. 64.—A Deep-sea Fish, *Macrurus parallelus.*

parts (120 to 2600 fathoms) of the great oceans, and are common in the North Atlantic and Pacific. There are two dorsal fins, the first short-based, the second of great horizontal extent. The anal fin is also extensive, and, like the second dorsal, reaches to the hind extremity of the body, which tapers off to a filament. The scales are usually rough and spinous. The eyes are large, the mouth is small, and there is usually a single barbel on the chin. The pelvic fins are situated below the pectorals and have 7 to 12 rays. In some of the genera, such as *Macrurus*, the mouth is inferior and the snout conical and prominent and

supported by the enlarged nasal bones. In the less specialised forms the mouth is terminal, the scales are cycloid, and the dorsal fin is more or less continuous.

Gadidæ.

In the Gadidæ or Cod-like fishes the mouth is large and terminal, bounded above by the premaxillary bones only; the cheek-plates are much reduced, the gill-openings wide. In most the suture between the two frontal bones has disappeared. The pelvic fins are anterior to the pectorals (jugular position). The dorsal fin occupies nearly the whole of the back, and in many cases is divided up into two or three portions; the anal fin in like manner may be divided into two parts. The scales are small and cycloid. The "Cod-fishes" and their allies chiefly inhabit the north temperate and arctic seas, but the abyssal forms are of wide distribution. The Burbot (*Lota vulgaris*, 483) occurs in, and is confined to, fresh water. Many of the Gadoid fishes are valued as food and form the basis of an important fishing industry in European and North American seas, and a staple food of the people in some of the northern lands.

Cod.

The Cod, *Gadus morrhua*, 476, is a most important food-fish; the quantity landed annually at British ports alone is according to the latest returns not less than 2,000,000 cwts., the value of which is over £1,000,000. The Cod grows to a length of four feet and may attain a weight of a hundred pounds. It is a northern fish and does not occur nearer the equator than 40° N. lat. The British forms are greenish or brownish olive, with numerous spots, but the more northern forms are darker in colour and without or with fewer spots. Cod are caught, by means of lines and trawls, at any depth down to 120 fathoms. The fishes are kept in ice and sent to market as fresh fish, or they are salted. Most of the salted Cod consumed during the Lent season comes from Newfoundland. The liver of the Cod yields a readily digested oil of great value in the treatment of emaciated patients, those suffering from lung complaints benefiting especially. The preparation of cod-liver oil is an important industry on the Norwegian coast; the name of the oil must not be taken too literally, for the livers of all species of *Gadus*, not the Cod only, are used as a source of it.

The tail of the Cod, although externally similar to that of most

Teleostean fishes, e. g. that of the Salmon, being externally symmetrical above and below the middle, is internally symmetrical also. The vertebral axis is not uptilted, and the hæmal spines of the last few vertebræ are not expanded into hypural bones (477). The fin-rays of the lower part of the tail-fin are carried by interspinous bones, and it is probable that the true caudal fin has atrophied, and has been replaced by a continuous series of fin-rays belonging to the dorsal and anal fins.

In the Cod and other species of *Gadus* there are three separate fins on the back, and two anal fins between the anus and the tail-fin. Of the European species of *Gadus* other than the Cod the most important are the Haddock (474), Whiting (479), Pollack (478), Coal-fish (475), Bib (480, skeleton), Poor-cod (481), and Poutassou.

Haddock. The Haddock, *Gadus æglefinus*, 474, is distinguished from the Cod by its black lateral line and the blackish patch above the pectoral fin. It attains a length of three feet in the arctic latitudes, although it is smaller on the southern coasts. Much of the fish is eaten fresh, but it is most in favour in the smoked and dried condition.

Whiting. The Whiting, *Gadus merlangus*, 479, extends from Norway to the Mediterranean, and is abundant in shallow water round all the

Pollack. coasts of Britain and Ireland. The Pollack, *Gadus pollachius*, 478, is found in rocky localities along the Atlantic coasts of Europe from Norway to the Mediterranean. In the British Isles it is commonest off the Devon, Cornish and Irish coasts. It is of more interest to the sea-angler than to the regular fisherman.

Hake. The Hake, *Merluccius vulgaris*, 473, can be distinguished from the species of *Gadus* by its having two dorsal fins and one anal fin. There is no barbel on the chin; the frontal bones are not fused together as in the Cod. The Hake is a large fish, growing to four feet in length; it is voracious, with strong teeth, and follows the shoals of Mackerel, Pilchards and other migratory fish. The flesh is soft and of fair quality, most of it is preserved as "Stock-fish."

Ling. The Ling, *Molva vulgaris*, 485, is a northern but wide-ranging fish; it is fairly common around the British Isles. Most of the Ling caught are cured and dried.

The Burbot or Eel-pout, *Lota vulgaris*, 483, is a fresh-water member of the Cod family. The skin is unpleasantly slimy, and has small scales which are embedded so as to give the surface a pitted appearance. The colour varies considerably in different localities. There is a single barbel which hangs from the middle of the chin, and from which the French name Barbotte and the English Burbot, meaning "bearded," have arisen. As in the Ling there are two dorsal fins, the base of the second covering half the entire length of the animal and being balanced below by the anal, which, however, is shorter in the base. In England the Burbot grows to 1 or 2 feet and attains a weight of 2 or 3 lbs., but in the Rhine it grows much larger, sometimes weighing as much as 30 lbs. In Alaska it grows to 60 lbs., such a fish being not less than 6 feet long. The Burbot is of a retiring disposition, and in the daytime lurks in holes and beneath stones. It is largely a nocturnal feeder and subsists on small fishes. Its flesh is said to be excellent, but it shares with the Pike and Barbel the disadvantage of harbouring the young form of a tape-worm (*Bothriocephalus*) which can complete its growth in the human body if it is not killed in the process of cooking. The Burbot is widely distributed over Central and Northern Europe, extending eastward to India, and is also found in North America. In England it is very local; it occurs in the Trent and other rivers of the eastern part of England, but not in the Thames. Burbot.

While in most of the Cod-like fishes there is a single barbel, in the Rocklings the number is increased. The commonest British Rocklings are the Three-bearded Rockling, *Motella tricirrhata*, 486, and the Five-bearded Rockling, *Onus mustela*, 487; small fishes, with the front dorsal fin reduced to a narrow, delicately-rayed fringe, more or less concealed in a longitudinal groove. Rockling.

The Greater Fork-beard, *Phycis blennioides*, 482, though common in the Mediterranean and in the North Atlantic, is only occasionally caught off the British coasts; the exhibited specimen was caught at Fleetwood, in Lancashire. There is a single barbel on the chin, and the pelvic fins are reduced each to a single long ray, forked at the extremity, looking like a forked barbel and probably serving the same purpose. Fork-beard.

The series of "Cod-fishes" on exhibition ends with the Torsk, Torsk.

Brosmius brosme, 488, a large fish of both shores of the North Atlantic, with the dorsal and anal fins not divided, and with the tail-fin rounded behind, and the Trifurcated Hake, *Raniceps trifurcus*, 489, a small fish of northern Europe, with a large, broad, depressed and somewhat frog-like head.

ACANTHOPTERYGII.

Spiny-fin Fishes. Wall-case 12.

The suborder Acanthopterygii is a very large one, including the Perches, Mackerels, Flat-fishes, Gobies, Blennies and Gurnards. The majority of marine fishes belong to this suborder. Except in a few cases the foremost rays of the dorsal and anal fins are spinous and hard, instead of being jointed and flexible or "soft." The upper border of the mouth is supported by the premaxillary bones, to the exclusion of the maxillæ, which are toothless. The right and left parietal bones are separated. The gill-opening is in front of the pectoral fin and is usually large. The pelvic fins are forwardly placed and their skeleton consists typically of one spine and five soft rays; the pelvic bones are usually firmly connected with the clavicular arch.

Perciformes (Perches).

The Perciformes constitute a large division of the Acanthopterygian fishes and consist chiefly of marine forms. The pelvic fins are thoracic in position, *i. e.* are about as far from the snout as are the pectoral fins. The stalk of the tail is rarely much constricted, and the rays of the caudal fin are not strongly forked at the base as they are in the next division (Scombriformes). The division is of some antiquity, Berycoid and Serranid fishes being found in Upper Cretaceous strata. The existing members are widely distributed, but are absent from the arctic and antarctic seas. The various families comprising the division Perciformes are distinguished the one from the other by the number of gills present, the coalescence or distinctness of the two lower pharyngeal bones, the presence of two nostrils or one on each side, the number of spines and soft rays in the various fins, the presence or absence of a shelf of bone projecting from the suborbital bones to support the eyeball, the insertion of the ribs either on transverse

processes of the vertebræ or directly on the centra, and the characters of the post-temporal bone, the teeth, and the barbels.

The Berycoid fishes (e. g. *Beryx splendens,* 493, Wall-case 12) Beryx. are the most ancient and generalised of the Acanthopterygian fishes, and were richly represented in the Upper Cretaceous by several genera (e. g. *Hoplopteryx,* fig. 65) which are closely related to, if not identical with, the existing genera. They have a short

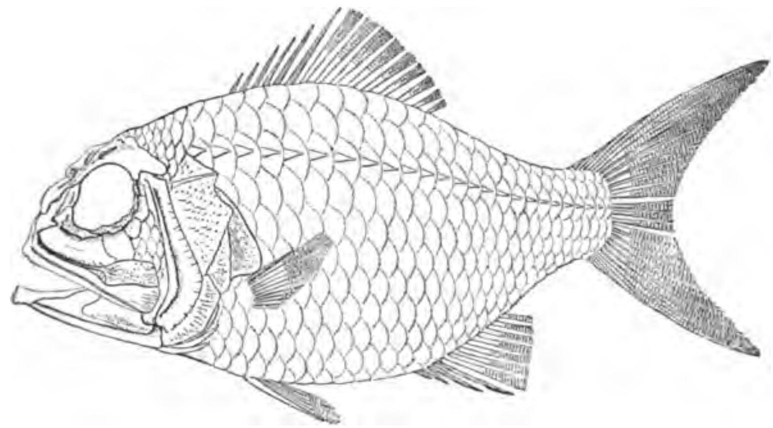

FIG. 65.—Restoration of an extinct form of Beryx, *Hoplopteryx lewesiensis.* (After A. S. Woodward.)

body; the pelvic fins have an exceptionally large number of fin-rays, 6–13 soft rays and one spine. The eyes are large, the cleft of the mouth is oblique, the jaws have small teeth, the bones of the gill-cover are more or less armed with spines. In the septum or partition between the two eyeballs is a bone, the orbitosphenoid, which is present in the more primitive Teleostean fishes such as the Herrings and Salmons, but is wanting in the Perches and Mackerel-like fishes.

Some of the Berycoid fishes (e. g. *Beryx* and *Holocentrum,* 496) have a persistent pneumatic duct to the air-bladder, and this again is evidence of the Berycoids constituting a connecting link between the Physostomous fishes such as Herrings and Salmons and the typical Acanthopterygians such as the Perches. In the recent forms and in some of the extinct forms the tail is deeply cleft, and

the scales are ctenoid and uniform. All are marine, except the little Pirate Perch, *Aphredoderus sayanus* of North-American fresh waters; some, like *Holocentrum*, live at the surface of the sea; others, like *Beryx*, occur only at great depths and are typical members of the deep-sea fauna. The Berycoid fishes do not attain a large size; the exhibited specimen of *Beryx splendens* (493) is an exceptionally large one. Specimens of *Beryx* are occasionally brought to the London markets, not so much from their food value as the fact that their bright red colouring makes a fine display on the fishmonger's slab. The specimens come mostly from the Bay of Biscay and the coast of Portugal.

Myripristis.

Myripristis (495), like *Holocentrum*, lives at the surface in tropical seas, near the coast; it is esteemed as food. The fishes of the genus are very pugnacious and always ready to quarrel with their own kind. In Hawaii the natives take advantage of this trait to catch the Uu (*Myripristis murdjan*). Having obtained one alive by a net or other means, they attach a string to it and put it back into the water in front of the crevices in the rocks in which these fishes lurk. The other fishes soon come out to fight it, and the crowd is brought to the surface of the water by slowly drawing in the string; a net is passed cautiously beneath and the whole crowd captured.

The Monocentridæ are a small family containing a single genus, *Monocentris*, 500, differing from the Berycidæ in the scales being larger and stouter, forming a rigid carapace, in the pelvic fins being reduced to a single spine with 2 or 3 soft rays, and in the stoutness of the spines of the dorsal fin. The Japan species (500) is sometimes called the Pine-cone-fish.

The Centrarchidæ are fresh-water fishes of small size, rarely exceeding six inches in length, common in North America. The principal forms are the Sun-fish (*Lepomis*), the Black Bass (*Micropterus*), acclimatised in some parts of continental Europe, and *Kuhlia* (501) of Polynesia. They are all valued as food.

The Lobotidæ, a very small family containing two genera only, *Lobotes*, 505, and *Datnioides*, 504, are allied to the Centrarchidæ. *Lobotes* is a widely distributed marine form, *Datnioides* occurs in the rivers and estuaries of the Ganges and the East Indies.

Archer-fish.

In the Toxotidæ or Archer-fishes (e. g. *Toxotes jaculator*, 506)

the body is rather short and laterally compressed, with cycloid scales of moderate size, a pointed snout, with large gape and a projecting lower jaw. The dorsal fin is set far back and has five strong spines; the anal fin has three spines. The scales extend over the soft portions of both dorsal and anal fins. The Archer-fish is a fresh-water fish of the East Indies, Queensland and New Zealand. It is so called because of its habit of rising to the surface and discharging from its mouth a drop or jet of water upon an insect which it perceives resting on a leaf or twig overhanging the water, in order that the insect may fall into the water and become an easy prey. The fish continues this entertaining practice in captivity, and the Malay people keep the "Ikan sumpit," as they call it, for purposes of amusement.

The Perches (family Percidæ) are fresh-water fishes of the northern hemisphere, with the spinous dorsal fin longer than the soft dorsal, and the latter not much more developed than the anal fin; the anal fin has one or two spines only. The Perch, *Perca fluviatilis*, 507, well known to anglers by the conspicuous vertical dark bars extending from the back some distance down the sides, is a bright-looking fish, rather rough to the touch owing to the fine serration of the free edges of the ctenoid scales. Although the specific name of the Perch is *fluviatilis*, the fish is more at home in lakes than in rivers; in fact the Perch cannot spawn in places where there is any considerable current. Perches are essentially gregarious fish, swimming about and seeking their prey in shoals, but as they grow old they become more solitary in their habits. It is curious to note that large and small Perch do not associate together; large Perch, in fact, do not hesitate to devour the young of their species. The Perch is a good fish for the table, its flesh being firm, clean and white, but most of the specimens caught by anglers are discarded, and there is no demand for such fish in the British markets. In Russia, on the other hand, the Perch is an important article of diet. The size of the Perch varies much in different waters, depending largely on the relative abundance or scarcity of food. Perch up to 3 lbs. in weight are not infrequently caught in Britain; Frank Buckland vouches for the capture of genuine Perch of 4½ lbs. A few cases are recorded of fish weighing 7 or 8 lbs., but there is a suspicion

Perch.

that these records may refer to the Sea-perch or Bass (*Morone labrax*, 511, Wall-case 13), which is sometimes found in tidal rivers, but can be readily distinguished by its having 8 to 10 spines in the front dorsal fin, whereas the true Perch has 14 to 16.

Pope. The Pope, or Ruffe, *Acerina cernua*, 509, is an obscure little fish, found in England, but not in Scotland or Ireland, common in Scandinavia, Russia and Siberia. In England it scarcely reaches six inches in length, but in Siberia it grows much larger. It differs from the Perch in the incomplete separation of the spinous dorsal fin from the soft dorsal, and in the border of the preoperculum being armed with 10 or 12 spines and the operculum with a single spine. It is not known how the name "Pope" came to be applied, but the fish has suffered a great deal of persecution in consequence of its unfortunate appellation, for during the Protestant movement in England, when hatred of everything savouring of Roman Catholicism was rife, the people of the midland towns used to catch the unoffending fishes, fix a cork on the dorsal spines of each, and put them back into the canal or stream until, as Frank Buckland describes it, the surface of the water for miles was covered with bobbing corks. Hampered by the corks and consequently unable to catch any food, the unhappily-named fishes were left to die a lingering death.

Sandra. The largest fishes of the family Percidæ are the Pike-perches,

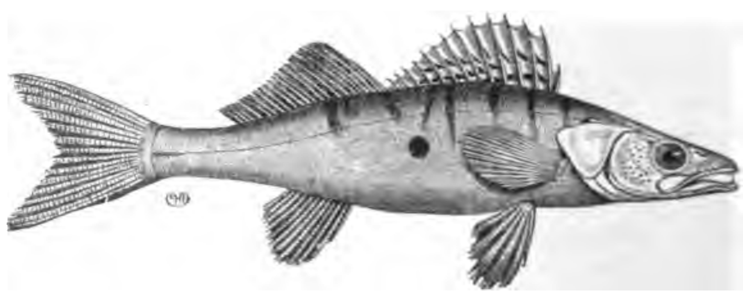

FIG. 66.—Pike-perch, *Lucioperca sandra*.

such as the Sandra, *Lucioperca sandra*, 508, and fig. 66, which is a common fish in the lakes and rivers of the continent, although absent from Britain, and grows to a length of three or four feet in

favourable situations and may weigh as much as 25 lbs. It is one of the most esteemed of fresh-water fishes. It has been proposed to naturalise the fish in British waters, but its voracity renders it an undesirable inhabitant of streams where Trout and other valuable fishes are kept.

Sea-perches. Wall-case 13.

The Sea-perches constitute a very large family, the Serranidæ, widely distributed around the shores of all tropical and temperate seas, while a few are found in the depths of the ocean. They differ from the Percidæ in having a ledge of bone projecting internally from the second suborbital bone to support the eyeball, and in other osteological characters. Some of the Sea-perches attain to a great size, witness the *Epinephelus lanceolatus* in Table-case 40, which is 7 feet 3 inches long, and the *Stereolepis gigas* in Table-case 46, which is 5 feet long. The species of these large fishes are rather difficult to determine, and the name Jew-fish Jew-fish.

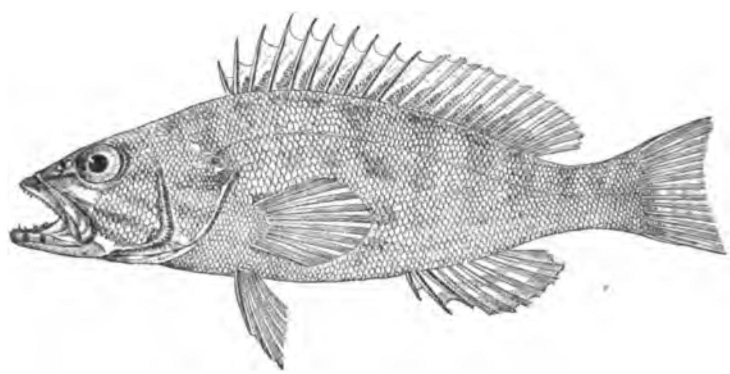

FIG. 67.—A Sea-perch, *Serranus cabrilla*.
(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.)

is applied indiscriminately to any large specimens of *Stereolepis* or *Epinephelus*. The specimen of *Epinephelus cernioides*, 1103, although not so large as the two fishes just mentioned, is of interest in having been caught in British waters, namely, off the coast of Loo in Cornwall. As a general rule these large fishes are of a uniform dull brown or greenish colour, in striking contrast with the spotting and banding in the young—compare, for instance, the young of *Epinephelus lanceolatus*, 523, Wall-case 13,

with the adult in Table-case 40. *Epinephelus* is a large genus, and many of the species do not attain to a greater size than those shown in the Wall-case 13.

The Sea-perches of the genus *Serranus* are interesting because some of them, such as the Comber, *Serranus cabrilla*, 524, and fig. 67, are hermaphrodite, regularly so and not as an exceptional circumstance. A few enter brackish and fresh water.

Bass. The Bass, *Morone labrax*, 511, is a form of Sea-perch common on the British coasts, appearing in shoals in the shallow seas and estuaries between June and September. It is a voracious fish with a remarkably large stomach, and it received from the ancient Romans the appropriate name of "Lupus" or Wolf. The Greeks and Romans esteemed the Bass very highly as a table-fish, but at the present day the fish does not enjoy high repute. This is the fish that Aristotle declared to be the most cunning of fishes, because when surrounded by the net it digs for itself a channel through the sand by which to escape. Specimens of 8 or 10 lbs. are not uncommon, and authentic cases of Bass of 22 to 28 lbs. are on record.

The Stone-bass, *Polyprion americanus*, 513, is a fish found in the open ocean; it is sometimes called the Wreck-fish because it is often met with in the neighbourhood of floating timber, to which it is attracted by the Barnacles, &c. upon which it feeds.

Murray-cod. Occurring plentifully in the Murray River and other rivers of South Australia is the Murray-cod, *Oligorus macquariensis* (514, Wall-case 12, floor), a fish which attains to a length of more than three feet and a weight of 100 lbs. It is valued on account of the excellent flavour of its flesh, as also is the Hapaku, Hapiku or Hapuku, *Oligorus gigas*, of the coasts of New Zealand. Another genus of large fishes is *Lates*, represented by *Lates calcarifer*, 530, of the coasts and estuaries of India, South China, and North Australia, and a skeleton of *Lates niloticus*, 55 inches long (Table-case 33), a well-known fish of the Nile and other rivers of tropical Africa. *Mesoprion* and *Genyoroge* are large genera, represented in the exhibited series by specimens 541–546 and 537–540. *Mesoprion bohar*, 544, the "Mumea" of Samoa, is poisonous as food. *Genyoroge sebæ*, 540, is called the "Government" Bream by the Australian fishermen because of a red-brown mark on the

side of the body which resembles the government "broad-arrow" mark. The fish grows to a weight of several pounds, is much esteemed for the table, and is forwarded to market in a smoked condition. *Aprion virescens*, 536, the "Uku" of Hawaii, is a green, long-bodied fish, widely distributed through Polynesia, and one of the best food-fishes of that region.

Histiopterus is a genus of rather aberrant fishes of Japan and Australian seas, having a strongly compressed body with very small scales, and a small mouth set at the end of a much produced snout. The teeth are fine, close-set, and equal, and the palate is toothless. *Histiopterus recurvirostris*, 550, is called the "Bastard Dory."

Closely allied to the Serranidæ are the Pseudochromididæ, in which the spines of the dorsal and anal fins are feeble and few. The fishes are marine and of generally wide distribution; most of them are small, e. g. *Latilus* (554) and *Malacanthus* (555). The Tile-fish, *Lopholatilus chamæleonticeps*, is one of the largest of the family, and is restricted in its distribution, occurring only in moderately deep water (70–130 fathoms) in the American part of the North Atlantic. It is very brightly coloured; the triangular "fatty fin" on the back of the head is remarkable, and is characteristic of the genus *Lopholatilus*. Tile-fish.

The Tile-fish was first caught in 1879 off Nantucket Island, several hundred specimens being obtained. It was found to be an excellent table-fish and was expected to become a regular article in the American fish markets. For three years it was fairly common and many thousands were captured.

In March 1882 a vast destruction of the Tile-fish took place; millions of the dead fish were found floating on the surface of the ocean over an area of some 5000 to 7000 square miles. Prof. Verrill has pointed out that at the bottom of the region in question there is a band of temperate water (48° to 50° F.) between the Arctic current on the one hand and the cold deep sea on the other, and that in this temperate band the Tile-fish live and breed. He suggests that the heavy gales of the early part of 1882, and the displacement of much shore ice over the area, caused such a chilling of the warm tract of water as to kill off the fishes living in it, whose dead bodies were thus scattered far and wide.

After the wholesale destruction of 1882 it was feared that the Tile-fish had become extinct, but in recent years (since 1892) specimens have been caught in fair numbers at the usual depths of 70 or more fathoms and in the original district, namely around 40° N. lat. and 72° W. long. This history of the destruction of the Tile-fish is important as being one of the very few cases in which we know of the almost complete destruction of a species by natural causes—that is to say without the intervention of man as a hunter or as a carrier of disease.

Band-fish. Resembling the last family in the feebleness of the spines, of which there are only three in the dorsal and one in the anal fin, are the Cepolidæ or Band-fishes, e. g. the *Cepola rubescens*, 556, a fish common in the Mediterranean and sometimes taken on the British coasts. It grows to about 18 or 20 inches, and is of a bright red colour. The body is long and band-like, reminding one of the Ribbon-fishes (Wall-case 19), with which at one time the Cepolidæ were classed. The dorsal and anal fins extend nearly the whole length of the body.

The Hoplognathidæ of the coasts of Australia, Japan, and Peru, with the single genus *Hoplognathus* (557), have the spinous portion of the dorsal fin well developed; the body is compressed laterally and covered with very small ctenoid scales. The chief distinguishing feature is the coalesence of the teeth to form a kind of beak with a sharp edge. The Sillaginidæ, another small family with a single genus, *Sillago*, are small fishes related to the Meagres of the next family, the Sciænidæ, from which they differ in the greater length of the base of the anal fin and the presence of teeth on the vomerine bone. There is a separate spinous dorsal fin, but it is short-based as compared with the soft dorsal. *Sillago ciliata*, 559, is known as the "Whiting" in Australia, where the true Whiting (*Gadus merlangus*, 479, Wall-case 11), a fish of northern distribution, does not occur. The misapplication of popular names in the colonies is due to the early settlers, who, coming across an animal new to them, had only three courses open to them, to accept the name by which it was known to the natives, to invent a new name for themselves, or to apply the nearest or least inappropriate name already existing in their vocabulary, and in almost all cases they preferred to follow the last course. Thus, they called the birds Sparrows and Robins and Thrushes, and the

Colonists' Names.

fishes Trout and Herring and Whiting, and their children and grand-children, who had no opportunity of knowing what the real Trout and Whiting were like, innocently adopted the names used by their elders. The ultimate result is that modern colonial people visiting England for the first time express surprise at the difference which exists between their own animals and the similarly-named animals of this country, and rather than rename their own, they allude to our British forms as the "English Trout," the "English Whiting," and so on.

Sciænidæ.

The Sciænidæ are fishes common near the sandy shores of all warm seas, with the soft dorsal much more extensive than the spinous dorsal and the anal fins, the pelvic fins thoracic in position, and with no teeth on the palate. Some of the fishes attain to a great size, and most are edible. *Sciæna diacanthus* is a common fish on the coast of the East Indies, ascending the rivers for a great distance from the sea. The specimen of this species in Table-case 48 is 6 feet 3 inches long. One of the European species, *Sciæna aquila*, the Meagre (1101) has an extremely wide range, specimens having been caught on the British coast, the Cape, and Southern Australia. *Corvina* (562) differs from *Sciæna* in having the second ray of the anal fin strong.

Meagre.

In *Umbrina* the snout overhangs the mouth and there is a short barbel under the chin. The Umbrina or Ombre, *Umbrina cirrhosa*, 566, is an important food-fish of the Mediterranean, and in the delicacy of its flavour ranks high; it was well known to the ancients. *Pogonias chromis*, 564, is called the Drum or Big Drum because of the extraordinary sounds which it produces, drumming sounds which can be heard by persons in vessels lying at anchor on the coasts of the United States, where the fishes abound. The sounds are either produced by the clapping together of the pharyngeal teeth, which are strongly developed, or else by the fishes beating their tails against the bottom of the vessel in order to free themselves from the parasites that infest their skin. The Drum grows to a length of four feet and a weight of 100 lbs. *Micropogon* (563) differs from *Pogonias* chiefly in that the pharyngeal teeth are conical instead of being flat-topped and adapted for crushing (see pharyngeal teeth of the Drum, 565).

Drum.

The Gerridæ (e. [redacted]*la*, 575, Wall-case 14) are small, silvery [redacted] seas and frequently

Wall-case 14.

also in fresh water. The mouth is very protractile and descends when thrust out; the dentition is feeble, and the lower pharyngeal bones are fused together. The Latrididæ are a small family of southern fishes of large size, related to the Serranidæ on the one hand and the Haplodactylidæ on the other. The species of *Latris* are among the most important food-fishes of Australia and New Zealand. The Trumpeter, *Latris hecateia*, 576, grows to 50 or 60 lbs., and *Latris ciliaris*, 577, to 20 lbs. The Haplodactylidæ (e. g. *Haplodactylus*, 580, and *Chilodactylus*, 579) differ from the last in the anal fin being shorter, but agree with them in the pelvic fins being set relatively far back; they bear some resemblance to the Sparidæ, but differ in having the lower rays of the pectoral fin thickened and not branched. The Pristipomatidæ (*Pristipoma*, 581, and *Diagramma*, 586) is another family of no special interest.

Trumpeter.

The Sea-breams and Snappers belong to the family Sparidæ; they are coast fishes, widely distributed, and mostly carnivorous. The spinous and soft portions of the dorsal fin are continuous and nearly equal in extent; the lower rays of the pectoral fin are branched; the lower pharyngeal bones are separate. The genera of the family are distinguished the one from the other chiefly by the characters of the teeth. In *Chrysophrys*, 606, and other forms, such as *Sargus*, *Lethrinus*, *Sphærodon*, *Pagrus*, and *Pagellus*, which feed on hard-shelled crustaceans and molluscs, the hinder teeth are strongly developed as molars. In such genera as *Cantharus*, *Box*, *Crenidens*, *Dipterodon*, and *Gymnocrotaphus*, on the other hand, the teeth at the front of the jaw are moderately broad, cutting teeth, and there are no molar teeth.

Dentex vulgaris, 589, is one of the larger species of the genus. It is common in the Mediterranean, and is sometimes caught on the south coast of England. The Old-wife, *Cantharus lineatus*, 587, with numerous longitudinal bands on the sides of the body, is also sometimes found in the English Channel.

Sheepshead.

The Sheep's-head of the United States, 594, is the largest species of the genus *Sargus*; it attains to a weight of 15 lbs. and a length of three feet, and is highly esteemed on account of the excellence of its flesh; it is common in sandy bays from Cape Cod to Texas. Several species of *Sargus* occur in the Mediterranean

and the neighbouring parts of the Atlantic Ocean, and are popularly known as Sargo, Saragu, Sar, names derived from the word "Sargus," by which these fishes were well known to the ancient Greeks and Romans. In some of the Mediterranean species of Sparidæ hermaphroditism is of normal occurrence.

The well-known "Pagro" of the Mediterranean is *Pagrus vulgaris*, 596, an important food fish, found also off Madeira and the Canary Islands. The Snapper, *Pagrus unicolor* (fig. 68; 597, skeleton) of the seas of Australia and New Zealand is considered very good eating, and attains a length of three feet and a Snapper.

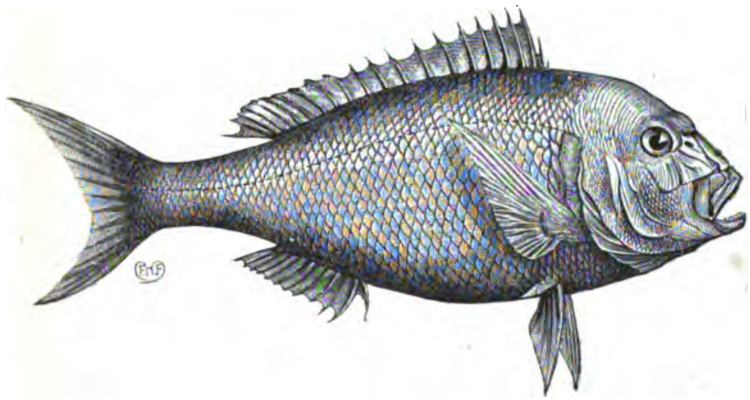

FIG. 68.—Snapper, *Pagrus unicolor*.

weight of 20 lbs. *Pagrus argyrops* of the coasts of the United States is an important food-fish, and is known as the Scup, Porgy, or Mishcup. Another species of *Pagrus* is the famous Red Tai (*Pagrus major*) of Japan, a crimson fish which is as much a national emblem of that land as the rising sun and the chrysanthemum.

The Gilt-head or Dorade, *Pagrus auratus*, 605, and fig. 69, is a Gilt-head. common food-fish of the Mediterranean, and is occasionally taken off the south coast of England. It was one of the fishes that were kept in captivity by the ancient Romans. The fish is called "Gilt-head" because of the brilliant golden spot, band, or crescent between the two eyes; the name Dorade, sometimes spelt Daurade, is clearly derived from the Latin "aurum," gold, and

refers to the same distinctive mark. The ancient Greeks called it "Chrysophrys," signifying "Golden-Eyebrow," a word which at the present day is employed to designate a genus of the Sparidæ to which at one time the Gilt-head was referred.

Sea-bream. The Sea-bream, *Pagellus centrodontus*, 602, is not in any way related to the Bream (349, Wall-case 8), which is a fish allied to

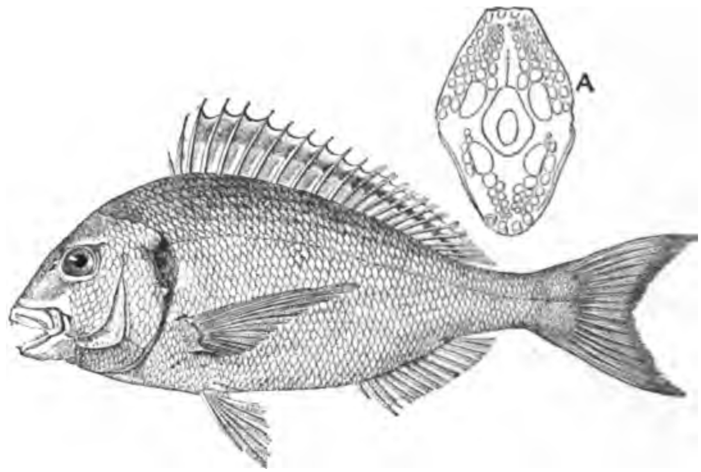

FIG. 69.—Gilt-head or Dorade, *Pagrus auratus*.
A, view of the widely open mouth showing the form of the teeth.
(From Boulenger, Camb. Nat. Hist., vii, 1904, after Cuv. et Val.).

the Carps. The fish that the fishermen of Cornwall and Devon call the "Chad" is a young Sea-bream, without the black spot at the front of the lateral line that distinguishes the adult. The Cape Sea-bream, *Pagellus lithognathus*, 601, is larger than the British and Mediterranean species.

The Red Mullets (family Mullidæ) have affinities with the last family, the Sparidæ, but can readily be distinguished by the pair of erectile barbels which project downward and forward when the fish is feeding on the sea bottom, but lie back in grooves when the fish swims about. The two dorsal fins are separated and short-based, and the spines supporting the anterior one are feeble. Most of the Mullidæ are tropical fishes, but the common Red Mullet, *Mullus barbatus*, 609, occurs in Europe. The Red Mullet has long been famed for the delicate flavour of its flesh. It was

Red Mullet.

prized by the ancient Greeks and Romans, who paid extravagant prices for large specimens. The brilliant red colour of the skin which adds to the attractiveness of the Red Mullet as a table fish fades when the fish dies, but can be "fixed" by scaling the fishes directly they are caught, a process which causes the colour-cells or chromatophores to die in a fully expanded condition. Almost all the Red Mullet that finds its way to the London Markets is caught off the coast of Cornwall. The fish does not grow large, one of 15 inches in length and 2 lbs. or 2½ lbs. in weight would be considered above the average. The Surmullet is by some authorities regarded not as a distinct species, but the female of the Common Red Mullet. *Upeneus* (610–612) is a tropical genus of wide distribution.

The Scorpididæ are fishes of tropical and southern seas, the most remarkable of which is *Psettus sebæ* (614), in which the height of the body is greater than the length. The body is much laterally compressed; the dorsal and anal fins are long in the base and are almost covered over with scales. The Boar-fish, *Capros aper*, 615, of the small family Caproidæ, is a fish of the Eastern Atlantic and Mediterranean, sometimes caught in the English Channel. The mouth is very protractile, the surface of the body is very rough to the touch owing to the scales being not merely ctenoid, *i. e.* with a comb-like free edge, but spiny. Boar-fish.

The Chætodontidæ are tropical, marine fishes occurring in abundance in the neighbourhood of coral reefs. They are carnivorous, feeding on small invertebrates; most are of small size and some are of exquisite beauty of design and coloration. Yellow and black are the leading combinations; there is not infrequently a black band passing down across the eye and one or more striking black spots at the root of the tail or on the fins. The Chætodonts are sometimes called Butterfly-fishes from their brilliant coloration. The body is laterally compressed, the scales are small and extend on to the dorsal and anal fins. The teeth are close-set and minute and slender, whence the name of the family, signifying 'bristle-toothed.' The mouth is small and frequently is set at the end of a prolonged snout. The spinous and soft portions of the dorsal fin are continuous. Chætodonts.

Chætodon (616–621) is a genus with many species. The fishes

are small and very active in their movements. *Chelmo* (622) differs from *Chætodon* in having the snout produced into a more or less long tube. The fish is said to throw a jet of water from its mouth so that it lights upon an insect resting upon a leaf and causes it to fall into the water, when the fish seizes it. The statement, however, has probably arisen from a confusion between this fish and the Archer-fish, *Toxotes jaculator* (506, Wall-

FIG. 70.—*Heniochus macrolepidotus.*

case 12), which is known to catch insects in this manner. The *Chelmo* is a salt-water fish, and it is highly improbable that it feeds on insects at all.

Heniochus macrolepidotus (623–624, and fig. 70) has the fourth

dorsal spine greatly elongated and thread-like; the colours vary in different specimens, although the arrangement of the light and dark bands is much the same in all (compare 623 and 624). These fishes are among the commonest in the tropical Indo-Pacific area.

The species of *Holacanthus* are known generally as Angel-fishes, the name being specially applied to *Holacanthus ciliaris,* 629; they are larger than those of *Chætodon* and not less bright in the coloration; they have a stout spine projecting backward from the preopercular bone which is wanting in *Chætodon.* They are all esteemed as food, particularly the *Holacanthus imperator* (627), which attains a length of 15 inches. Angel-fish.

The genus *Pomacanthus* includes American fishes only; they are larger than the species of *Holacanthus,* and have about 10 spines in the dorsal fin instead of 14. The young are brightly coloured, frequently with yellow bands, and they differ among themselves considerably in their coloration; the adults are blackish. The Paru, *Pomacanthus paru,* 632, is a well-known fish of the West Indies.

In *Scatophagus* (633) and *Ephippus* (635) there is more distinction between the spinous and soft portions of the dorsal fin than in the majority of the Chætodonts, owing to the presence of a fairly deep notch, and the scales do not spread over the spinous portion; the preopercular spine is wanting. *Scatophagus argus* (633) is a common Indian shore fish, and is sometimes caught in the rivers. Old specimens of an Atlantic species of *Ephippus* (*Ephippus faber,* 635) show almost constantly bulbous enlargements of the frontal and supraoccipital bones (636), and sometimes also of the foremost neural spines. These swellings have been attributed to a diseased condition of the bones; whether or no this is the correct explanation, the right and left symmetry of the swellings, the constancy of their occurrence in old fishes, and the limitation of them to the bones above mentioned are features of interest. Ephippus.

The family Drepanidæ contains a single species, *Drepane punctata,* 637, occurring in the Indian Ocean and North Australian seas, closely related to the Chætodontidæ, but distinguishable by the very long, curved pectoral fins.

Surgeon-fish. Wall-case 15.

The Surgeon-fishes, fishes belonging to the genus *Acanthurus*, are readily recognised by the single, sharp, lancet-shaped spine with which each side of the tail is armed. When at rest the spine is hidden in a sheath, when erected it is a most dangerous weapon, which the fish uses by lashing the tail to right and left (647, *Acanthurus chirurgus*, the Surgeon-fish proper; 650, *Acanthurus sohal*, which is mounted with the back towards the observer so that the spines may be the better distinguished; and 651, a skeleton of *Acanthurus lineatus*, showing the relation of the spine to the caudal vertebræ). The spines are absent in very young individuals. The young Surgeon-fishes are more circular in outline than the adults, and are more compressed and have no scales; they were formerly thought to be distinct fishes and were described under the generic name *Acronurus*.

The Acanthuridæ are herbivorous or partly carnivorous fishes, common in tropical seas in the neighbourhood of coral reefs; they are fairly closely allied to the Chætodontidæ (Wall-case 14) and lead on towards the File-fishes (Wall-case 20). The maxillary is fused with the premaxillary bone, the mouth is small and not protractile, the jaws have either bristle-like or incisor-like teeth; there are no teeth on the palate; the post-temporal bone is fused with the cranium. The scales are minute and rough, either ctenoid or spiny; the dorsal and anal fins are long-based, the dorsal has the spinous portion less developed than the soft portion and not separated from it. *Acanthurus lineatus* (of which a skeleton is shown, 651) is a poisonous fish, producing "Ciguatera" similar to that caused by eating the flesh of the File-fishes.

Unicorn-fish.

Naseus, the Unicorn-fish, 643–645, and fig. 71, has usually two spines at the side of the stalk of the tail, one in front of the other, and these are not erectile as are those of *Acanthurus*. The name Unicorn-fish is applied because of a bony horn projecting forward above the mouth, sometimes two inches long in a fish of a length of 20 inches. This horn is continuous with the bones of the cranium (see skeleton 645), and is said to be used by the fish as it butts up against the coral. *Prionurus* (642) differs from *Naseus* in having a series of about six bony laminæ on each side of the tail instead of distinct spines.

The Teuthididæ (652–654) differ from the Acanthuridæ in the

pelvic fins having the inner and outer rays spinous, with three soft rays between. They are herbivorous and do not grow longer than 15 inches; they are confined to the Indo-Pacific Ocean.

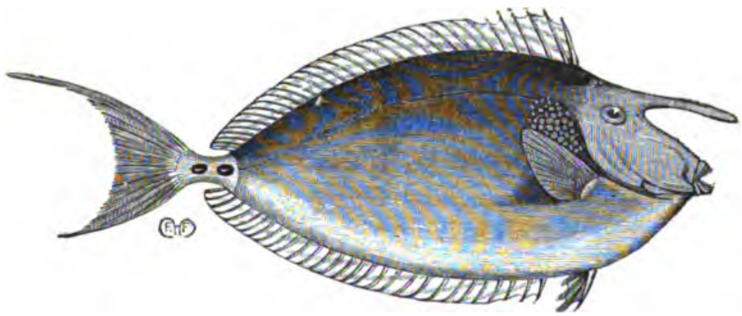

FIG. 71.—Unicorn-fish, *Naseus unicornis.*

In the Osphromenidæ there is much variation in the extent of the dorsal and anal fins, the spines of which are in some cases numerous, in others absent; the pelvic fins may have five soft rays, or the number may be reduced to one. A suprabranchial accessory organ of respiration is present; it is a paired organ situated in cavities behind the cranium. The fishes are confined

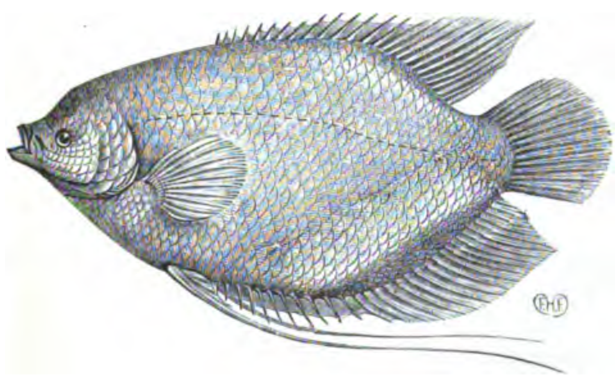

FIG. 72.—Gourami, *Osphromenus olfax.*

to the fresh-waters of Africa and Southern Asia. The Gourami, *Osphromenus olfax,* 655, and fig. 72, is the largest fish of the family, and is one of the choicest food-fishes of the East. It is a Gourami.

native of the Malay Archipelago, and has been introduced with success into India and Mauritius. The Gourami is essentially a vegetarian, but in a state of domestication is omnivorous and will consume meat, fish, frogs, insects, worms, and many kinds of vegetables, whence it has gained from the French colonists of Mauritius the name "porc des rivières," or "water-pig."

Fighting-fish. The Fighting-fish or Pla-kat of Siam (*Betta pugnax*, 656) is widely known as a pugnacious little fish. When the fish is quiet its colouring is dull, but in the presence of another of its kind it becomes excited in demeanour and the body shines with dazzling metallic colours, while the gill-cover is pushed out and forms a kind of black frill around the throat. The fish makes repeated darts at its antagonist, and the fight lasts until the fishes are tired. If the fight be interrupted by removing one of the combatants to another vessel, both become quiet and dull-coloured. The Siamese keep these fishes in glass bowls for the express purpose of watching the fights, and they will pit their favourite against another's, and stake large sums of money on the result of the fight.

Cichlidæ. The Cichlidæ and the following family, the Pomacentridæ, have a single nostril on each side, whereas in all the other families of Acanthopterygian fishes there are two nostrils on each side. There are four gills on each side in the Cichlidæ, but only 3½ in the three following families, the Pomacentridæ, Labridæ and Scaridæ. The two lower pharyngeal bones are fused together in the Cichlidæ, but less completely than in those three families. The Cichlidæ (657–658, and fig. 73) are fresh-water or brackish-water fishes of tropical and sub-tropical America, Africa and India. Our knowledge of these fishes has greatly increased of recent years in consequence of investigations in Lake Tanganyika, the fish fauna of which is largely made up of Cichlid, or as they were formerly called, Chromid fishes. The division of the family is based upon the characters of the spines and teeth, the latter exhibiting a wide range of variation. *Etroplus* (657) is an Indian genus; *Tilapia* (658) is African, and, like several other African Cichlids, is remarkable for the care with which the female parent guards the eggs from danger by carrying them about in the mouth. This habit is, curiously enough, shared by an entirely unrelated

fish, the *Arius* (376, Wall-case 10, floor), a fish of the family Siluridæ. In some of the American forms, such as *Cichla*, the

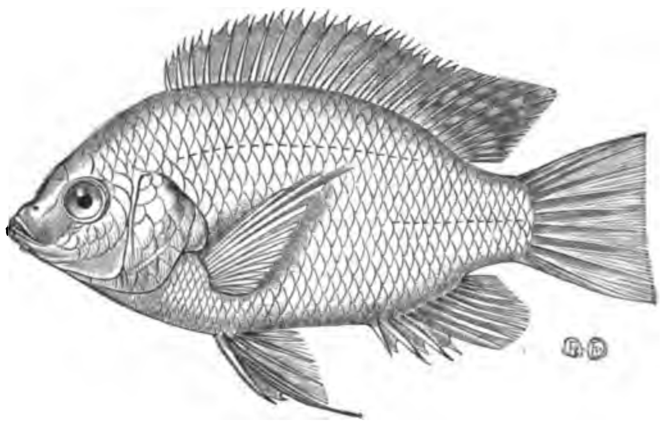

FIG. 73.—Bulti, *Chromis niloticus*.

males develop on the top of the head a hump which disappears after the breeding season.

The Pomacentridæ (662–666) are small fishes (see *Dascyllus*, fig. 74) intermediate in character between the Cichlidæ and the Coral-fishes.

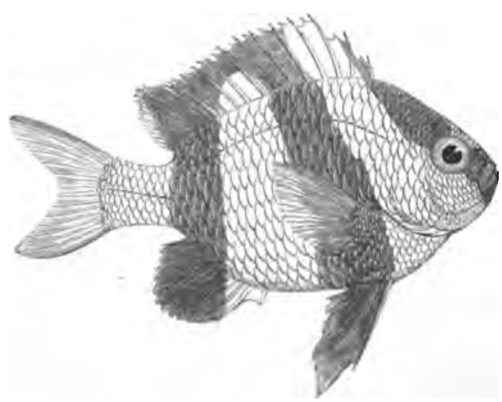

FIG. 74.—*Dascyllus aruanus*, nat. size.
(From Günther, "Study of Fishes.")

Labridæ, occurring in warm and tropical seas, frequently of brilliant coloration, and living in the neighbourhood of coral reefs.

The species of *Amphiprion* (662) are among the smallest. Some of the Australian forms are of interest because of their habit of associating with species of giant Sea-anemone (*Discosoma*). On pushing a stick into the mouth orifice of one of these Sea-anemones there almost invariably dart out two or three of the little fishes, which return into the interior of the anemone when the disturbance is over.

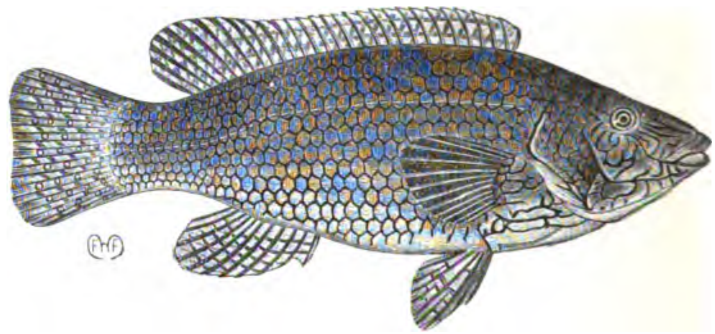

FIG. 75.—Ballan Wrasse, *Labrus maculatus*.

Wrasses. The Wrasses (family Labridæ, 667–692, and fig. 75) have the lower pharyngeal bones completely fused (673, and fig. 76), and

FIG. 76.—Upper and lower pharyngeal bones of the Ballan Wrasse, *Labrus maculatus*.

bearing conical or tuberculate teeth; the front teeth of the jaws are conical, the lateral teeth more or less coalesced at the base,

the palate without teeth. The fishes have thick, fleshy lips (whence the German popular name "Lippfisch"), and a slimy skin with cycloid scales.

The Labridæ are of wide distribution, occurring among the rocks and sea-weed of the coasts of all tropical and temperate seas. They are good eating, although the flesh is too soft and glutinous to suit some palates; they have no great commercial value and only find their way to certain markets. The colours are brilliant and vary considerably in different individuals of the same species, and in many cases there is a regular difference in colouring between the male and female during the breeding season. In the Cuckoo or Striped Wrasse, for instance (*Labrus mixtus*, 668), the male usually has blue streaks or a blackish band along the body, while the female has two or three large black blotches across the back of the tail. The male loses his bright colours in the winter, and three dark spots similar to those of the female, but fainter, then become apparent. The female was formerly supposed to be a distinct species from the Cuckoo Wrasse and was called the Three-spotted Wrasse. The Wrasses proper (genera *Labrus, Crenilabrus, Ctenolabrus, Acantholabrus*) are confined to the seas of Europe and northern Africa. They build nests of masses of soft sea-weed, tightly crammed into rock crevices, with the large amber-coloured eggs evenly dispersed through the mass. Both sexes take part in the building of the nest.

Occurring commonly in rocky, seaweed-clad parts of our coasts, particularly the southern coasts, are, besides the Cuckoo Wrasse above mentioned, the Ballan Wrasse, *Labrus maculatus*, 670, fig. 75, a larger fish than the former, attaining a weight of 7 or 8 lbs.; the Gold-sinny or Corkwing, *Crenilabrus melops*, 676, rarely exceeding nine inches in length, a brownish or reddish fish with dark bands down the sides, and rings, sometimes with dark centres, on the fins, the female distinguishable by a black spot immediately in front of the tail fin; *Ctenolabrus rupestris, Acantholabrus palloni* and *Centrolabrus exoletus*, the last, known as the Rock-cook, being a more northern form than most of the Wrasses, occurring even on the coast of Greenland. *Julis vulgaris* (685) and *Julis giofredi* (686) are common Mediterranean fishes

occasionally found on the south coast of England; it has been stated that they are respectively the male and female of the same species of fish. *Lachnolaimus falcatus* (677), with the first three spines of the dorsal fin produced into streamers, is the Hog-fish of the West Indies. *Epibulus* (680) and *Gomphosus* (691) are remarkable for their long snout, with terminal mouth.

Parrot-fish.

The Scaridæ or Parrot-fishes (693–701, and fig. 77) are allied to the Wrasses, but have the teeth of the jaws so coalesced as to form beaks (see skeleton of *Pseudoscarus*, 1028, Table-case 32). These beaks are extremely hard and are used by the fish to bite off pieces of coral, which together with molluscs and sea-weed make up the sum of their food. The right and left lower

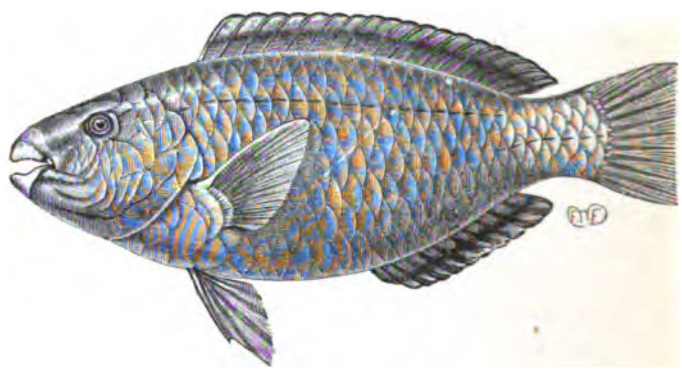

FIG. 77.—Parrot-fish, *Pseudoscarus troschelli*.

pharyngeal bones are completely fused and are armed with flat-topped teeth which bite against similar teeth borne by the upper pharyngeal bones, and are used to grind up the pieces of coral and the shells of the molluscs.

The Parrot-fishes are brilliantly, some gaudily, coloured, and the largest species grow to three or four feet. Some are valued as food, others are reputed to be poisonous. *Scarus cretensis* (694), a Mediterranean form, was much esteemed as food by the ancients. It feeds almost entirely on sea-weed, but sometimes on molluscs; if the fish has been feeding on the mollusc known as the Sea-hare

(*Aplysia*) it causes violent diarrhœa when eaten. *Odax* (700) is a southern genus, occurring on the coasts of Australia and New Zealand; the edges of the jaws are sharp and the individual teeth composing them cannot be distinguished. *Coridodax pullus* (701) is the Kelp-fish or Butter-fish of New Zealand; it lives on the small organisms growing on sea-weed, and is largely used as food.

Scombriformes (Mackerels).

The Scombriform fishes, including the Mackerels, Horse-mackerels, Sword-fishes and their allies, are closely connected with the Perciformes; they are carnivorous and marine and many are of wide distribution. The spinous dorsal fin, if distinct, is supported by short or feeble slender spines. The pelvic fins are thoracic in position, with not more than five soft rays in addition to the spine; rarely without the spine but with more than five jointed rays. The stalk of the tail is much constricted; the rays of the caudal fin are usually numerous and strongly forked at the base, embracing a considerable portion of the expanded hypural bones. The scales are usually very small or absent.

The first family, the Scombridæ, includes fishes like the Mackerel (704), Bonito (709), and Tunny (707), with fusiform body, not laterally compressed, with pectoral fins set rather high up the sides of the body, with a distinct lateral line, with wide gape and conical teeth. The premaxillary bones are large and not protractile. There are no free spines in the dorsal and anal fins; the soft dorsal fin, the hinder part of which is in most cases broken up into finlets, is longer than the spinous portion; the hind part of the anal fin may, like the dorsal, be in the form of separate finlets. The Scombrid fishes are abundant in all the seas of the tropical and temperate zones; they include some of the swiftest inhabitants of the sea, and not only are they extremely active, but they have great powers of endurance. Their muscles are of a redder colour than those of most fishes and more resemble those of warm-blooded animals. They spawn in the open sea.

Most are pelagic, a few occur in the depths of the sea; many, such as the Mackerel and Tunny, are valued as food.

Mackerel. In the Mackerel, *Scomber scombrus*, 704, the fins are small, and the tail is deeply forked. The colours are beautiful and the general design is a dark green-blue on the back, with about 30 irregular black bands across the back and down the sides, and with a delightful play of pink and pale green on the belly according to the position in which the fish is held. This sheen is observable in the dried skin and is due to an interference of light-waves caused by minute particles of guanin or some other substance of a uric acid nature in the skin.

The Mackerel ranges from the south of Norway to the Canary Isles, and throughout the Mediterranean, also along the Atlantic coasts of the United States of America. Like the Anchovy it invades the North Sea during the summer months and retires before the winter. The shoals of Mackerel follow the Clupeoid fishes in their migrations; on the British coasts they usually leave the open sea and approach the land in their pursuit of the young Pilchards and Sprats. The Mackerel is generally taken near the surface in drift nets and occasionally near the bottom in trawls; the most productive British fisheries are off the south-west coasts of England and Ireland.

The Spanish Mackerel, *Scomber colias*, 706, is essentially a fish of the Mediterranean and adjacent Atlantic, but occasional stragglers are caught as far north as the Channel Isles and the English coast. It is sometimes called the Spotted Mackerel because of the distinctive blotches or spots; it has an air-bladder, which is wanting in the common Mackerel.

In the genus *Thunnus* the anal and the second dorsal fins have each from 7 to 10 finlets, and the front, undivided portions are deep and short-based; the stalk of the tail has a distinct lateral keel supported by a bony ridge of the vertebral centra; the pelvic fins are small, the pectorals are more or less elongate; the scales of the pectoral region are crowded and form what is called

Tunny. the 'corselet.' The Tunny (*Thunnus thynnus*, fig. 4, p. 14) is one of the largest Teleostean fishes, and grows to 10 feet and a weight of 1,000 lbs. It is abundant in the Mediterranean and ranges to

the south coast of England and southwards to Tasmania. The specimen exhibited in Table-case 38 was caught at Weymouth, and is 8 feet 4 inches long. The Tunny fishery is a regular industry in the Mediterranean and has been so since the time of the ancient Romans, to whom the salted flesh of the Tunny was known as "Saltamentum sardicum." *Thunnus pelamys*, the Bonito, 709, ranges over all the tropical and temperate seas and is well known to sailors, to whom it affords good sport. It rarely exceeds three feet in length. The Bonito pursues the Flying-fish, indeed, the sudden appearance of a crowd of Flying-fish above the surface of the sea generally points to the presence of a Bonito or some similar Scombroid fish. 'Albacore' is a sailors' name for any species of *Thunnus* with long pectoral fins; it probably includes other species than *Thunnus alalonga* (1021, Table-case 38) and *Thunnus albacora*. The Bonito and Albacore are preyed upon by the Sword-fish, which is their chief enemy, and also by Sharks.

Bonito.

Albacore.

In *Cybium* (711), as in *Thunnus*, there is a firm keel at the side of the stalk of the tail, but the teeth of the jaws are large and strong; they are laterally compressed and are disposed in a single series. The scales are more reduced than in most Scombroid fishes. The species of *Cybium* occur in the tropical parts of the Atlantic and Indian Oceans, frequenting the coast region rather than the open sea; they grow to four or five feet in length.

Elecate (712) stands rather apart from the Scombridæ in having no detached finlets in the hinder part of the dorsal and anal fins. It is placed in a family by itself, the Rhachicentridæ, *Rhachicentrum* being an earlier name than the more familiar *Elecate*. The spinous dorsal fin is reduced to about eight small spines, which are free and unconnected by fin-membrane; the pectoral fins are not set high up the sides of the body, the head is depressed, and there is no keel on the side of the tail.

Wall-case 16.

Wall-case 16 is occupied by the family Carangidæ, fishes allied to the Mackerels (Scombridæ, Wall-case 15), but not having separated finlets in the hinder parts of the dorsal and anal fins.

The dorsal spines are few; the anal fin usually has one or two spines detached from the rest of the fin. The scales are either

FIG. 78.—Yellow-tail, *Seriola lalandii*.

small or absent; frequently there are enlarged scutes on the sides of the body and tail; the premaxillary bones are more or less protractile. The Carangid fishes have a wide range, and are found in tropical and temperate seas. The principal genera are *Caranx* (Horse-Mackerels), *Seriola* (Yellow-tails, fig. 78), *Naucrates* (Pilot-fish, fig. 79), *Trachynotus* and *Chorinemus*. The

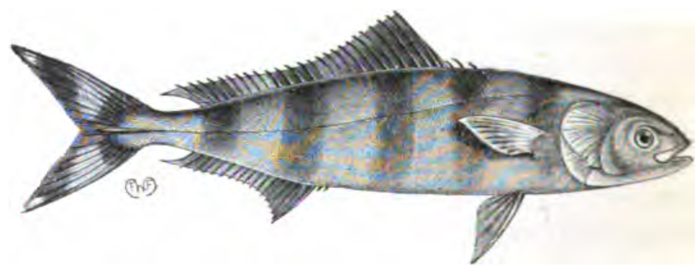

FIG. 79.—Pilot-fish, *Naucrates ductor*.

genus *Caranx* is represented in British seas by the Scad, *Caranx trachurus*, 719, the young of which live in small parties in the neighbourhood of jelly-fish, and seek shelter beneath them when disturbed. Other species shown are *Caranx affinis*, *C. ciliaris*, and *C. speciosus*, all from the Indian Ocean. The name Yellow-tail is applied to any species of *Seriola*, but more particularly to *Seriola lalandii* (721, and fig. 78) of the Southern Atlantic and Seas of Japan; *Seriola gigas* (722) and *S. dumerilii* (723) are also shown.

The Pilot-fish, *Naucrates ductor*, 725, and fig. 79, is a pelagic fish found in association with large fish, especially Sharks. It is named Pilot-fish because of its supposed habit of conducting the Shark towards suitable prey. The association with the Shark may, however, be possibly due to the fact that the *Naucrates* feeds on the parasites that infest the Shark, and also on small pieces of flesh that escape the Shark when feeding, while the well-established fact that the Pilot-fish is not attacked by the Shark may rather find its explanation in the superior agility of the former than in any sentimental reciprocity on the part of the Shark. The Pilot-fish is known to follow ships for long distances for the sake of the refuse thrown overboard, but it usually deserts the ship on nearing land. It occurs in all tropical and temperate seas and attains a length of about twelve inches. The remaining Carangid fishes exhibited are of no special interest. Pilot-fish.

At the top of Wall-case 17 the family Trichiuridæ is represented by the Hair-tail, *Trichiurus lepturus*, 739, and the Scabbard-fish, *Lepidopus caudatus*, 738, *Ruvettus pretiosus*, 741, and *Thyrsites atun*, 740. In the Trichiuridæ the premaxillary bones are not protractile as they are in the previous family, the Carangidæ; the body is elongate and laterally compressed; the spinous portion of the dorsal fin is much longer than the soft portion and the spines more or less feeble; there are no free spines to the dorsal and anal fins; the pectoral fins are set low down the sides of the body, the scales are small or absent. The fishes of this family are pelagic and widely distributed, and many occur at great depths. In the Hair-tail (739) the body is ribbon-like, and tapers to a point behind, there being no caudal fin; in the Scabbard-fish (738) the dorsal fin is not divided into spinous and soft portions, and the pelvic fins are wanting. Two other fishes belonging to this family, *Lepidopus tenuis*, 971, and *Aphanopus carbo*, 982, are shown in the case of Deep-sea Fishes, Cabinet-case 44, and a specimen of *Euoxymetopon poeyi*, 1096, six and a half feet long, from Mauritius, is shown elsewhere in the Gallery. Wall-case 17. Hair-tail.

The Sword-fishes (Xiphiidæ and Histiophoridæ) are too large to exhibit in the Wall-case among the families to which they are most nearly related, and are placed in the special case (24) that stands in the centre of the Gallery. The only specimens representing these families in the Wall-case are three vertebræ (742) from the tail region of a large Sail-fish (*Histiophorus*) showing how the caudal vertebræ interlock by means of forwardly directed laminæ of bone arising from the front of the neural and hæmal spines. A somewhat similar but less

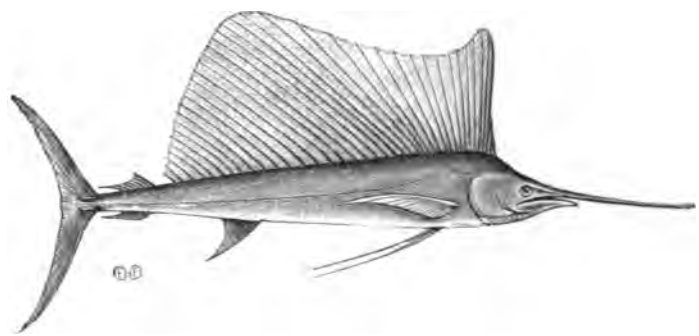

FIG. 80.—A Sword-fish, or Sail-fish, *Histiophorus gladius.*

pronounced interlocking occurs in the tail vertebræ of the Mackerel (see 705, Wall-case 15).

Sword-fishes. Floor-case 24.

The Sword-fishes (Floor-case 24) are among the largest of the Teleostean fishes, and may attain a length of fifteen feet. They live in the open ocean, and are strong and rapid swimmers. The Sword-fishes of the Indian and Pacific Oceans, sometimes called Sail-fishes, belong to the genus *Histiophorus* (fig. 80), and have long, narrow pelvic fins. The Sword-fishes of the genus *Xiphias* are of world-wide distribution, and have no pelvic fins; they have transverse processes to the vertebræ and short ribs, whereas *Histiophorus* has not. In the Histiophoridæ there is, at the front of the lower jaw, a supernumerary bone known as the predentary bone; this is wanting in *Xiphias*. The "sword" or rostrum is formed by the prolongation of the

premaxillary and maxillary bones, and is an important weapon of offence. The Sword-fishes frequently attack Whales, though for what purpose is not clear, and so great is the strength of the fish when rapidly moving that the "sword" is occasionally driven into the timbers of a ship, as is shown in the specimen on the floor of the case (1081, fig. 81). In very young specimens of the Sword-fish the upper jaw is not longer than the lower. The large dorsal fin of perfect specimens is said to project above the surface of the water and to act more or less as a sail. In old specimens the dorsal fin is very greatly reduced in height, except at the anterior end. In addition to the complete specimens of *Histiophorus gladius* and *H. brevirostris* are shown a skeleton

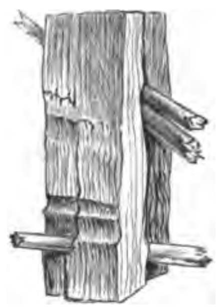

FIG. 81.—Part of the timber of a ship pierced by Sword-fishes.

and a skull of *H. brevirostris* and the rostrum of a large *Histiophorus gladius*.

Returning to the consideration of Wall-case 17, the family Bramidæ is represented by Ray's Bream, *Brama raii*, 746 (a fish not related to the Common Bream, 349, Wall-case 8, nor to the Sea-bream, 602, Wall-case 14), and *Pteraclis velifer*, a fish of the Indian Ocean with remarkable enlargement of the dorsal and anal fins. The family Coryphænidæ includes the Dolphin-fishes, the commonest species of which is *Coryphæna hippuris*, 744, and fig. 82, p. 172, of wide distribution in warm seas and common in the Mediterranean. These fishes have a short, deep snout, not protractile; there are no free spines in the dorsal and anal fins, and the pectoral fins are inserted rather low down

Wall-case 17.

Dolphin.

the sides. The Dolphins are so called from a confusion between them and the Porpoise-like animals of that name. They are pelagic in habit and pursue the Flying-fish; they are powerful swimmers and attain a length of six feet. The display of rapidly changing and flashing colours seen when the fish is taken out of the water is of short duration, and the fish when dead is dull in colour. The flesh is highly esteemed.

On the floor of Wall-case 17 is shown a remarkable, clumsy-looking fish, *Luvarus imperialis*, 743, the sole species of the family Luvaridæ. It is widely distributed over the world, but is not commonly met with; occasionally, as in the case of the specimen exhibited which was caught at Guernsey, the fish is found in British waters. The mouth is small and set low down

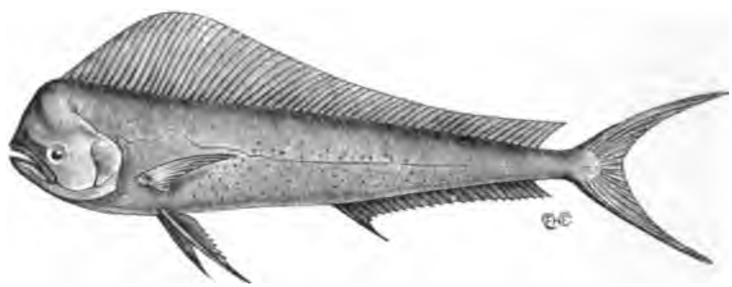

FIG. 82.—Dolphin, *Coryphæna hippurus*.

the head and has a feeble dentition; the dorsal and anal fins are supported by inarticulated, widely-set rays, and there are no free dorsal or anal spines. The pectoral fins are inserted low down, and the pelvic fins are much reduced. The surface of the body is rough, with minute scales.

Zeorhombiformes (Flat-fishes, &c.).

Wall-case 18. The Zeorhombiform fishes depart from the typical Perch-like fishes in having the body strongly compressed and with the precaudal region very short, the abdominal cavity being comparatively small and the anus set well forward. The fin-rays of the pelvic fin may be as many as seven or nine. The division

includes the family Zeidæ (John Dory, &c.), Amphistiidæ (extinct), and Pleuronectidæ (Plaice, Sole, &c.). In the first two families the body is symmetrical about the median plane, in the third family the one side, either the right or the left, is pale and the other side dark; the two eyes are on the dark side and the greater part of the mouth is on the pale side.

In the Zeidæ the mouth is very protractile. The dorsal and anal fins are much elongated, the former with a distinct spinous portion, the latter with from one to four spines detached from the non-spinous portion of the fin. The pelvic fins have one spine and from six to eight soft fin-rays. A swim-bladder is present. The family is a small one, and the species most important in this country is the John Dory, *Zeus faber*, 750, a fish much valued for the table. In colour the John Dory is yellowish-grey, with wavy-bands, and a large black spot edged with yellow. The English name John Dory is said to be a corruption of an old Gascon name "Jan Dorée," signifying Gilt-Cock; another derivation is from "Janitore," after St. Peter, whose finger-mark was supposed to be the cause of the dark patch on each side. In Germany the fish is called "Petersfisch," and at Nice "Peï San Pierre." The Dory feeds on Sprats and similar fishes, and it swims with the median plane of the body not quite vertical, but slightly oblique. It is essentially a warm water fish; it occurs in the Mediterranean and along the Atlantic coast from Madeira to Norway; it is common in the English and Bristol Channels, where it is taken in the trawl; in the North Sea it is rare. *Zeus conchifer*, 751, of Madeira, is a larger species than the John Dory, and differs in the number and disposition of the bony plates that occur in the skin at the bases of the fin-rays of the dorsal and anal fins.

Dory.

The Amphistiidæ are an extinct family with the single genus *Amphistium*, from the Upper Eocene. *Amphistium* is interesting as being in all probability the prototype of the Pleuronectid fishes, before the origin of the asymmetry characteristic of that family. The dorsal and anal spines are few, and in continuous series with soft fin-rays; the pelvic fins have each a spine and eight soft rays.

Flat-fishes. The fishes of the family Pleuronectidæ, commonly known as Flat-fishes (figs. 83 and 84), lie upon their side when resting on the bottom of the sea. The front part of the skull is twisted in such a manner that the two eyes are on the upper surface, and as may be seen by reference to the cranium of the Halibut, 755, the hinder part of the skull that contains the brain does not share in the torsion. The under surface of the fish, known as the "blind" side, is flat and white in colour, whereas the upper surface is pigmented and more convex. The dorsal and anal fins are extensive and form a kind of fringe to the flattened body. The paired fins are often reduced, sometimes absent. There is no swim-bladder. The Pleuronectidæ constitute a large family of fishes, almost all of them marine. They are valuable food-fishes and are represented in British waters by the Sole, Turbot, Brill, Plaice, Halibut, &c. In the Turbot and Brill the eyes are on the left side, in the others they are on the right side. The food of the Flat-fishes consists principally of molluscs, crustaceans and sea-worms, but the Turbot and Brill feed on fishes, such as the Launce, Herring, Whiting, and even small fishes of their own family, such as the Sole and Plaice.

Adalah. The least specialised of the family Pleuronectidæ is the Adalah, *Psettodes erumei*, 752 and 753, fig. 83 A, of the Indian Ocean and seas of China and Australia; the pelvic bones and fins are placed as in an ordinary fish such as the Perch, and the dorsal fin does not extend on to the head. It has been pointed out above that the two eyes of the Flat-fishes are on the same side of the body, but this does not apply to the very young. The fishes commence their existence as perfectly symmetrical fishes with their eyes on opposite sides of the head and their jaws similar on the right and left sides. As development proceeds and the body becomes more and more flattened, one of the eyes moves to the edge and then over to the same side of the body as the other eye, owing to a twisting of the front part of the skull. The Adalah is interesting in that it retains more completely the bilateral symmetry of the young than do any of the other Flat-fishes. The eye which migrates—sometimes the right, sometimes the left, since both right-handed and left-handed forms occur in this species (compare 752 and 753)—remains on the edge of the head, and does not come over completely on to the pigmented

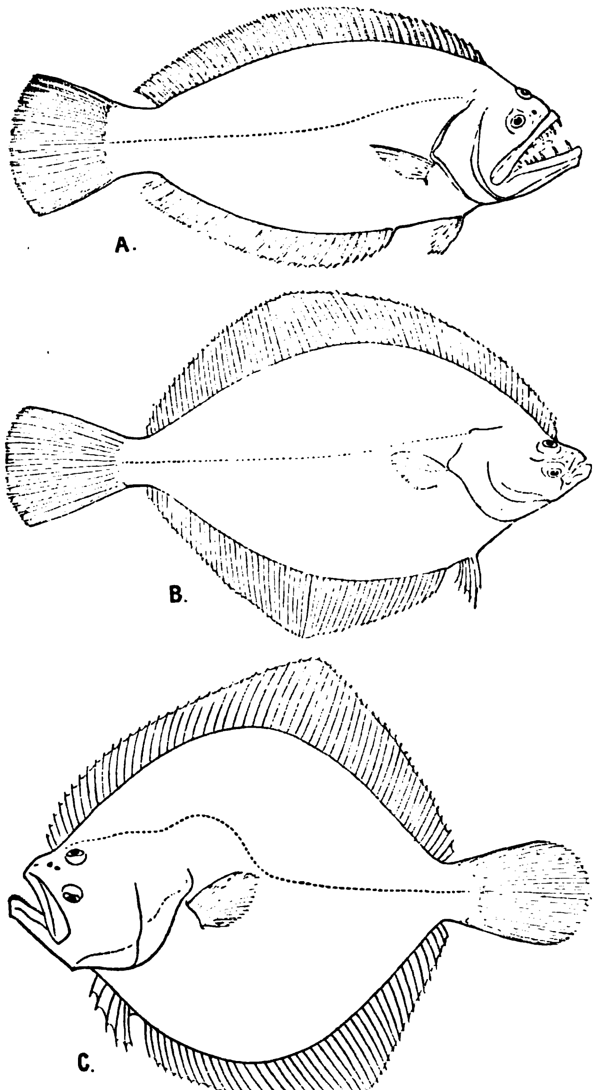

Fig. 83.—Flat-fishes.

A, Adalah, *Psettodes erumei*: B, Plaice, *Pleuronectes platessa*; C, Turbot, *Rhombus maximus*.

(After Boulenger, Camb. Nat. Hist., vii, 1904.)

side of the body. The right and left jaws of this fish are almost equally developed, and the teeth are much more powerful than in Flat-fishes generally.

Halibut. After *Psettodes*, the least specialised of the Flat-fishes is *Hippoglossus*, a genus including the Halibut, 754. In *Hippoglossus* the eyes are on the right side, the mouth is terminal and large, and teeth are present on both sides of the mouth. The body is long and comparatively narrow, and the dorsal fin commences above the more dorsally placed of the two eyes. The lateral line has a slight curve; the scales are cycloid. The Halibut inhabits the deeper waters along the southern shores of the Arctic Ocean. It occurs off Spitzbergen, Norway, Iceland, Newfoundland, Alaska, California and Kamschatka. It is taken chiefly on long lines, at depths ranging from 50 to 100 fathoms. About 150,000 cwts. of Halibut, valued at £300,000, are landed in Britain annually, mainly from the Iceland and Faröe banks. The Halibut is the largest of the Flat-fishes and commonly attains a length of six or seven feet; a specimen six feet long (1036) is shown on Table 49.

Hippoglossoides, represented by the Long Rough Dab, *Hippoglossoides limandoides*, 763, a fish of 12 or 15 inches in length, living in rather deep water in the north European seas, resembles *Hippoglossus* in that the eyes are on the right side and the mouth is terminal and large, with teeth on both sides; but the anterior end of the body is not much narrowed; the dorsal and ventral edges are rather straight; the scales are ctenoid; the lateral line is straight.

Turbot and Brill. In the genus *Rhombus* the mouth is large and terminal, with teeth on both sides, the eyes are on the left side, and the ventral eye is anterior to the dorsal. The shape of the body is rhomboidal, the middle of the body being very broad; the lateral line has a semicircular curve anteriorly. The Turbot and Brill belong to this genus, the former being known as *Rhombus maximus* (756 and 757, fig. 83 C, and the latter as *Rhombus lævis* (759 and 760). The Turbot differs from the Brill in having no ordinary scales but pointed tubercles scattered in the skin (compare the tubercles 758 and the scales 761). It is broader than the Brill in proportion to its length. The Turbot ranges from the Mediterranean to the southern part of Scotland and

the Skagerak. It is a shallow water fish, being rarely taken in depths exceeding 40 fathoms. About 70,000 cwts. of Turbot, valued at £300,000, are annually landed in Britain, mostly from the North Sea trawling grounds. The Brill has the same general distribution as the Turbot.

Pseudorhombus russelli, 764, is a fish widely distributed over the Indian Ocean and seas of East Africa, China and Australia. Closely allied to it is *Paralichthys dentatus*, 765 and 766, the "Flounder" of the Atlantic coast of America. In this fish the middle fin-rays of the caudal fin are longer than the others, so that the hind edge of the tail is not rounded, but has the form of an obtuse angle.

The genus *Pleuronectes* is represented by the Plaice, the Flounder and the Dab. In this genus the mouth is terminal and very small, the teeth are more developed on the lower side than on the upper; the eyes are large and prominent, the dorsal fin commences above the dorsal eye; the scales are small and in some cases rudimentary. The Plaice, *Pleuronectes platessa*, 767–771, fig. 83 B, has uniform scales, some bright red or orange spots, a lateral line nearly straight, bony tubercles on the inter-orbital ridge, and a spine in front of the anal fin. The Plaice is comparatively a cold water fish. It is abundant all round the British and Irish coasts, on the coast of Iceland, and in the White Sea. It is very rare in the Mediterranean. It is taken only by the trawl, and in depths usually less than 30 or 35 fathoms. About 1,100,000 cwts. of Plaice, of the value of £1,200,000, are landed in Britain annually. Nine-tenths of the total are taken in the North Sea, where the young Plaice are mostly reared along the shallow coasts of Holland, Germany, and Denmark, from which they migrate off-shore as they grow older. The more northern forms, e. g. those taken off Iceland, are very dark in colour. Plaice.

The Flounder, *Pleuronectes flesus*, 774 and 775, has tubercles at the bases of the fin-rays of the dorsal and anal fin; the scales are rough along the lateral line, elsewhere they are rudimentary; yellow spots are only exceptionally present. The Flounder is an estuarine fish except in the spawning season, when it descends Flounder.

to the sea. It occurs on all the coasts of Europe from the Mediterranean to the most northern waters of the Baltic. In the Zuyder Zee and Baltic the Flounder fisheries are valuable, but in Britain the annual take is only about 35,000 cwts. valued at £18,000. The Flounder grows to about 3 lbs. in weight. The Dab, *Pleuronectes limanda*, 773, is a small fish of little commercial value.

Glyptocephalus, a genus related to *Pleuronectes*, is represented in British seas by two species, the Witch, *Glyptocephalus cynoglossus*, 777, and the Smear Dab, *Glyptocephalus microcephalus*, 776. This last is often sold in the London markets as "Lemon Sole," the small head and rounded outline of the body giving the fish some resemblance to the true Sole. An easy test may be applied by examining the scales with a lens, for the scales of "Lemon Sole" are cycloid, with smooth hind edge, whereas those of the Sole are ctenoid, with the exposed part rough and bristly or toothed.

The Scald-fish, *Arnoglossus laterna*, 778, is a small and unimportant fish with a skin which is thin and tears off so readily as to suggest that the fish has been scalded. Two species of Topknot occur in British seas, the One-spotted Topknot, *Zeugopterus unimaculatus*, 779, and Miller's Topknot, *Zeugopterus punctatus*, 780; the One-spotted Topknot is a more southern form than the other and is found as far south as the Mediterranean, whereas Miller's Topknot does not occur farther south than the Bay of Biscay.

The Megrim or Whiff, *Lepidorhombus megastoma*, 781, is a fish growing to about 18 inches in length, and occurring off the coasts of Britain and Scandinavia. *Ammotretis rostratus*, 782, and *Rhombosolea flesoides*, 783, are Australian forms of Flat-fish.

Sole. In the genus *Solea* the mouth is rather small and not terminal: it is curved downward towards the ventral edge. Teeth are present on the lower side only. The shape of the body is oval, the outline of the snout semicircular; the dorsal fin commences on the snout and is not continuous with the caudal; the lateral line is straight, but with an anterior dorsal curve on the head; the dorsal eye is anterior to the ventral. There are tactile filaments

on the lower side of the snout; the scales are ctenoid. Four species of *Solea* occur off our coasts, the Common Sole, the most valuable of the four, the Sand Sole, the Thickback and the diminutive Solenette.

In the Common Sole, *Solea vulgaris*, 784, fig. 84 D, the pectoral fins of both upper and under sides are of considerable size, and the nostrils of the two sides are similar. The markings of the upper side consist of longitudinal series of black blotches on a yellowish-brown ground. The Sole is the most valuable of the Flat-fishes on account of the delicacy of its flavour. It is a warm water fish, and is abundant in various localities around the coasts of England and Ireland, less common on the coast of

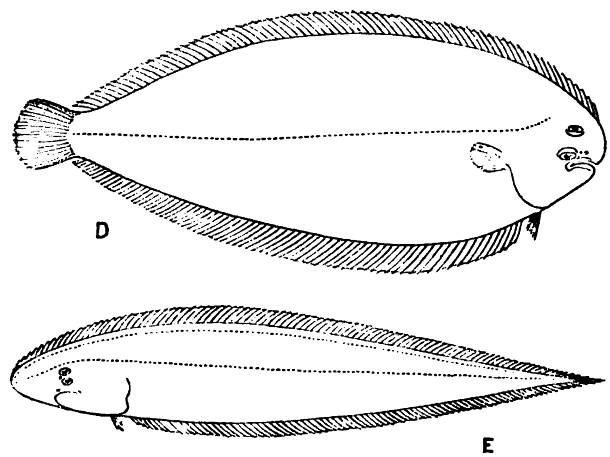

FIG. 84.—Flat-fishes (*continued*).
D, Sole, *Solea vulgaris*; E, *Cynoglossus lingua*.
(After Boulenger, Camb. Nat. Hist., vii, 1904.)

Scotland; it occurs also plentifully in the Bay of Biscay, off Portugal and in the Mediterranean Sea. The Sole is caught exclusively by the trawl, and in depths of less than 25 fathoms. Between 75,000 and 80,000 cwts. of Soles, valued at about £500,000, are landed in Britain annually. The principal British fishing grounds are off the Devon and Cornish coasts, and off

Ramsgate, Lowestoft, and Grimsby, but many of the Soles that come to the London market are caught off Portugal and Morocco.

Sand Sole. The Sand Sole, *Solea lascaris*, 786, differs from the Common Sole in being paler in colour after death, in having small black specks instead of large black blotches, and in the anterior nostril of the lower side being large and conspicuous and fringed internally. There is a black spot with a yellow margin on the pectoral fin. The Sand Sole is sometimes called the Lemon Sole, but the fish that is sold in London as the Lemon Sole is the Smear Dab, *Glyptocephalus microcephalus*, 776. The Thick-back, *Solea variegata*, 787, is smaller than the Common Sole, and the mouth is straight and more terminal. The colour-markings consist of five dark bands on a reddish-brown ground; the pectoral and pelvic fins are rudimentary. The Solenette *Solea lutea*, 788, is distinguished by the mouth being much curved and by the dorsal fin commencing on the extreme anterior end of the snout. There are dark blotches on a yellowish ground, and the dorsal and anal fins have a few scattered black fin-rays. The Solenette does not exceed five inches in length.

The genera *Synaptura* (789 and 790) and *Cynoglossus* (791, fig. 84 E) differ from *Solea* in the dorsal and anal fins being confluent with the caudal fin. In *Synaptura* the eyes are on the right side, the upper in advance of the lower; in *Cynoglossus* the eyes are on the left side, there are no pectoral fins, and the upper part of the snout is produced backwards into a hook. The fishes of these genera occur in the tropical seas of the Old World.

Gobiiformes (Gobies).

The division Gobiiformes is a small division of the suborder Acanthopterygii and includes a single family, the Gobiidæ; the species of the family are numerous, and the fishes are mostly marine and of small size, although some species of *Eleotris* grow to two or three feet in length. The pelvic fins are thoracic in position and consist of one feeble spine and four or five branched rays; they are in many species united to form a sucking disc.

The Gobies proper (genus *Gobius*) are common in shallow coastal waters around the British Isles and the Continent of Europe, the British forms including the Common Goby, *Gobius minutus*, 801, the Rock Goby, *Gobius paganellus*, 796, the Painted Goby, *Gobius pictus*, 802, the Spotted Goby, *Gobius ruthensparri*, 800, and fig. 85, and the Black Goby, *Gobius niger*, 799. The last species is mostly of an ashen grey colour, but when excited, as when in pursuit of its prey or when caught in a net, it changes to a dark smoke-colour. The Gobies are interesting on account of their breeding habits. The eggs are fixed by the female to the under surface of stones or weeds (see 1147, in Cabinet-case 29), or beneath a simple nest made out of shells of the Cockle or Limpet, or a Crab-shell. The Goby.

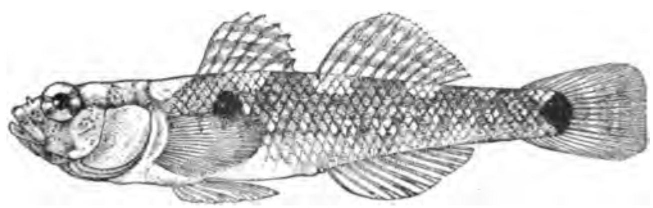

FIG. 85.—Spotted Goby, *Gobius ruthensparri*.
(From Boulenger, Cam. Nat. Hist., vii, 1904, after Holt and Byrne).

male is more brilliantly coloured than the female, and guards the eggs until they are hatched, remaining attached to the stone or shell by its pelvic sucker. The White Goby, *Aphia pellucida*, 803, has a transparent and colourless body, and was formerly supposed to be the fry of a larger fish. It does not live more than a single year. The Walking-fish or Jumping-fish, *Periophthalmus koelreuteri*, 804, is common on the mud-flats at the mouths of rivers in tropical Africa, Asia and Australia. It jumps about by the exercise of its stout pectoral fins and appears a curious object with its head raised and its two bulging eyes set close together near the top of the head.

Echeneiformes (Sucking-fishes).

The Echeneiformes constitute a small division of the Acanthopterygian fishes, containing a single family, the Echeneidæ, and characterised by the anterior dorsal fin being set well forward upon the top of the flattened head, and modified into a sucker by the right and left halves of the fin-rays being bent outwards so as to form a paired row of transversely placed lamellæ with rough edges. The margin of the sucking disc is soft and membranous (see isolated sucker, 808). The mouth is terminal, and the mandible advanced; the second dorsal and the anal fins are long in the base, without spines, and opposed to each other; the pectoral fins are inserted high up the body, the pelvic fins are thoracic in position and have each one spine and five soft fin-rays. The Echeneidæ were formerly regarded as allied to such Scombriform fishes as *Elecate* (712, Wall-case 15), but are now considered to occupy an isolated position.

Remora. The Remora or Sucking-fish, *Echeneis remora*, 807, and fig. 86, is found in all tropical and warm seas, and is sometimes caught as far

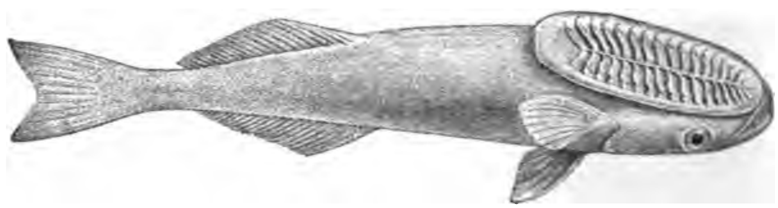

FIG. 86.—Remora or Sucking-fish, *Echeneis remora*.

north as the south coast of England. It attaches itself by means of its adhesive disc to Sharks, Whales, Turtles, and even to boats, and is thus carried from place to place. It is not a parasite and does no harm to the large animal to which it is attached. When thrown on the deck of a ship a Remora will lie on its back and cling so closely to the wood by its head sucker that it can only be dislodged by a forward sliding motion. The Remora feeds on small fishes and probably also on the skin parasites that infest large fishes and Whales.

Echeneis naucrates, 806, is closely allied to the Remora, but is more slender and has a relatively longer tail, and more fin-rays in the anal fin. In the Torres Strait the natives employ the *Echeneis naucrates*, or Gapu, as they call it, for catching Turtles. The fish is kept alive in water in the bottom of the canoe a thin string being fastened round its tail and through its gills. On a turtle being sighted in the vicinity of the canoe the Gapu is thrown out towards it; the fish immediately swims to and fastens upon the carapace. If the turtle is of small size it is hauled in by the line, the fish retaining its tenacious hold, but if it be a large one a native jumps overboard with a stronger line, and following the course of the fine line arrives at the turtle and securely ties it by the stronger rope, returns to the canoe and tows his captive to land.

Trigliformes (Gurnards).

The fishes of the division Trigliformes have an "armoured cheek"; the second suborbital bone is produced towards or fused with the pre-opercular bone and forms what is known as a "sub-orbital stay." The pelvic fins are thoracic in position. The division includes comparatively simple Perch-like forms such as *Sebastes* and aberrant forms such as the Gurnards, with fully armoured head, the Flying Gurnards, with enlarged pectoral fins, and the Lump-suckers, with pelvic fins forming a sucking disc.

Scorpænidæ. In the family Scorpænidæ the head is usually provided with spines, but is not completely cuirassed. The spinous dorsal fin is strongly developed and is usually longer than the soft dorsal fin; the anal fin usually has three spines. The fishes included in this family are carnivorous and marine and of wide distribution. Species of *Sebastes* and of allied genera are used as food. The dorsal fins of some, such as *Scorpæna, Pterois, Synanceia,* are provided with poison glands, and can inflict dangerous wounds.

Bergylt. The Bergylt, *Sebastes norvegicus*, 812, called by some fish-mongers the 'Soldier' on account of its bright red colour, is a fish confined to northern seas, such as those of Norway and Iceland;

it is esteemed as food, and occasionally finds its way to the London markets. *Scorpæna* is a widely distributed genus, the species *Scorpæna scrofa*, 816, being common in the Mediterranean; *Scorpæna cirrhosa*, 814, and *Scorpæna diabolus*, 815, are tropical forms. *Pterois miles*, 817, is an Indian fish remarkable for its brilliant red colour and the elongation of most of its fin-rays. Species of *Agriopus* (818–820), *Synanceia* (821–822), *Pelor* (824) and *Centropogon* (823) are also shown.

Wall-case 19. The division Trigliformes continues from Wall-case 18 into Wall-case 19, the first family in the latter being the Hexagrammatidæ, comprising carnivorous fishes, mostly of large size, although the specimen exhibited, *Chirus hexagrammus*, 827, is of moderate size only. They occur on the rocky coasts of the North Pacific, and some of them are valued as food-fishes. The head has no strong spines and is not cuirassed, and there is a single nostril on each side, whereas in the preceding family (Scorpænidæ) there are two. The spinous dorsal fin has feeble rays.

Bull-heads. The fishes of the family Cottidæ have two nostrils on each side and the head is usually provided with spines. The spinous dorsal fin is usually shorter than the soft dorsal and sometimes indistinct; the anal fin is without spines. The majority of the Cottid fishes are marine and found in northern seas. The best known forms of *Cottus* are the Miller's Thumb, *Cottus gobio*, 831, a little fresh-water fish growing to five inches in length, very bulky about the head and gills, with eyes set on the top of the head, and with pectoral fins large and spreading out like fans, and the marine Bull-heads, e.g. the Father-lasher, *Cottus bubalis*, 830, and the Sea-scorpion or Sting-fish, *Cottus scorpius*. *Cottus grœnlandicus*, 828, is probably but a northern form of *Cottus scorpius*. In America the species of *Cottus* are called "Sculpins," but in Britain the name Sculpin is applied to the Dragonet, *Callionymus lyra*, 865.

Lump-sucker. The Cyclopteridæ are distinguished from the Cottidæ by the small size of the gill-opening and by the pelvic fins being modified to form a sucking disc (835). The body is short and tumid,

and the spinous dorsal fin, if present, is short. The fishes are sluggish in habits, and of wide distribution. The best known forms in British seas are the Lump-sucker and the Sea-snail. The Lump-sucker, *Cyclopterus lumpus*, 833–834, and fig. 87, is a

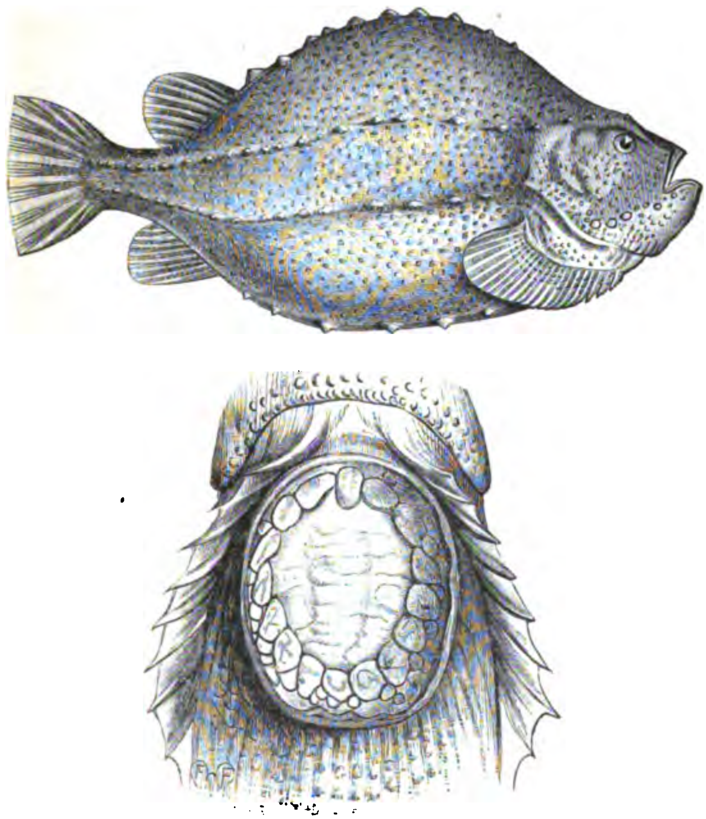

Fig. 87.—Lump-sucker, *Cyclopterus lumpus*; with a separate view of the sucking-disc.

clumsy-looking fish with a thick tuberculated skin and thin transparent bones. At the breeding season the male is more brilliantly coloured than the female. The eggs are laid in a pit made by the

male, who watches over them until they hatch. The young then cling to his body by their suckers and remain thus attached until sufficiently grown to take care of themselves. The Sea-snails are diminutive fishes, two species of which are common on the coasts of Cornwall and Devon, *Liparis vulgaris*, 836, and *Liparis montagui*, 837. A deep-sea form of Sea-snail, *Paraliparis fimbriatus*, 973, is shown in the series of Deep-sea Fishes in Cabinet-case 44.

In the families Platycephalidæ and Hoplichthyidæ the head is depressed, with spines, and with two nostrils on each side. The pelvic fins are widely separated and are set behind the pectorals in the former family and a little in advance of them in the latter. The fishes occur off the coasts in the Indian and Western Pacific Oceans (see 838–839).

The Agonidæ have the head completely cuirassed; the body is covered with bony plates. The pelvic fins are set close together and none of the fin-rays of the pectoral fin are modified as "feelers" as they are in the next family, the Triglidæ or Gurnards. The

FIG. 88.—Flying Gurnard, *Dactylopterus volitans*. (From Günther, "Study of Fishes.")

fishes are small; the only British form is the Pogge, *Agonus cataphractus*, 840.

Gurnards. In the Triglid fishes or Gurnards the head is completely cuirassed and provided with spines. Two or three of the lower-

most pectoral fin-rays are modified as delicate "feelers" which the animal uses as it moves about close on the sea-bottom in search of the small crustaceans that constitute its food. The pelvic fins are widely separated. The Gurnards are marine and are widely distributed in warm and temperate seas. The species found in British waters include the Grey Gurnard, *Trigla gurnardus*, 848; the Red Gurnard, *Trigla pini*, 845; the Cuckoo Gurnard, *Trigla cuculus*, 847, and the large Tub-fish or Sapphirine Gurnard, *Trigla hirundo*, 843. The Cape Gurnard, *Trigla capensis*, 849, does not differ materially from our Red Gurnard. Two species of the Armed Gurnard, *Peristedion* (841 and 842), and a specimen of the Australian *Lepidotrigla* (850) are also shown.

In the Flying Gurnards or Dactylopteridæ, fig. 88, the head is completely cuirassed, and the body is covered with hard, rough scales. The pelvic fins are set close together; the pectoral fins are divided into two portions, the second of which is very large in the adult. The Flying Gurnards inhabit tropical and warm seas, and are able to move through the air like the Flying Fish (*Exocœtus*, 452, Wall-case 11), though for shorter distances. The fish emerges from the water with considerable impetus, and the rapid agitation of the large pectoral fins enables it to traverse a distance of several feet before falling back into the water. The best known Flying Gurnard is the *Dactylopterus volitans* (851 and 852, skeleton), of the Mediterranean Sea and the temperate and tropical parts of the Atlantic Ocean. A specimen of an oriental species is also shown (853).

Blenniiformes (Blennies).

The division Blenniiformes or Jugulares includes a number of families of Acanthopterygian fishes in which the pelvic fins are set forward under the throat. There is no bony stay to the pre-operculum; the gill-opening is in front of the pectoral fin, the base of which is vertically disposed or nearly so. The division includes such fishes as the Weevers, Star-gazers, Dragonets, Blennies, Wolf-fishes and Toad-fishes.

Weevers.

In the first family, the Trachinidæ, are included the Weevers (fig. 89), small fishes with a large, protractile mouth, an elongate body with cycloid scales in oblique bands, a short spinous dorsal fin, and a long soft dorsal and anal. The Weevers are found off the coasts of Europe and West Africa. There are two British species, which can inflict painful wounds by means of the dorsal and opercular spines, which are connected with poison glands and are channelled for the passage of the venom. The Greater Weever,

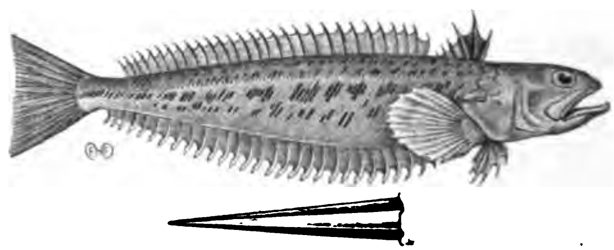

FIG. 89.—Weever, *Trachinus draco*, with an enlarged view of the poison spine.

Trachinus draco, 854, is a marketable fish in France; the flesh is of excellent flavour, but our fishermen usually prefer to throw the fish away than to run the risk of being pricked by the poison-spines when handling the fishes in sorting them out from the others in the boat or on the quay. The name 'Weever' is probably a corruption of the Anglo-Saxon "wivere," a viper or serpent, and has reference to the poison-spines. The Viperine Weever, *Trachinus vipera*, 855, is smaller than *Trachinus draco*, and lives in shallower parts of the coast; it differs also in having a fringe on the lips and in having no scales on the cheeks and gill-covers.

The Nototheniidæ are closely allied to the Weevers, but differ in the pelvic fins being widely separated. There is a single nostril on each side, and the scales are usually ctenoid, sometimes absent. The Nototheniid fishes occur mostly in southern seas. Three species of *Percis* are shown (857–859), and one of *Chænichthys* (856).

The Star-gazers (family Uranoscopidæ) are a natural and well-defined family deriving their name from the eyes being set on the upper surface of the large, broad head and looking upward as though gazing at the stars. The mouth slit is nearly vertical, the lower jaw being pushed well forward; granular ossifications are developed on the roof and sides of the head. These fishes are inhabitants of most warm and tropical seas. The common Star-gazer of the Mediterranean, *Uranoscopus scaber*, 861, was well-known to the ancient Greeks, who termed it the 'Agnos,' or Holy-fish; they also knew it as the 'Ouranoscopos,' or Heavenward-looking Fish. Star-gazers.

The Star-gazer is a poor swimmer and lives mostly in the mud and sand. A newly caught specimen put into an aquarium sinks to the bottom of the water and by a few vigorous shovelling movements of the pectoral fins buries itself in the sand until only the mouth and eyes project. Here it lies quietly, the only signs of its existence being a slight rhythmical disturbance of the sand as the expired water leaves the gill-chamber, an occasional jerk of the eyes, and the waving of a delicate filament which is attached to the floor of the mouth and projects through the mouth opening. This is evidently the bait with which the Star-gazer angles. When a small fish, mistaking this filament for a harmless worm wriggling in the sand, approaches within reach of the jaws, there is a sudden disturbance of the sand caused by the rapid opening of the Star-gazer's mouth, and the career of the small fish is ended.

In addition to the Common Star-gazer (861) are shown two species occurring in the seas of China and Japan (860 and 862) and specimens of the Australian forms *Kathetostoma* (864) and *Anema* (863).

The Callionymidæ include the Dragonets, fishes with a rather small and protractile mouth, a narrow gill opening, and a scaleless skin. The first dorsal fin is composed of a few flexible spines; the second dorsal and the anal fin are rather short. The fishes are small and widely distributed. The Common Dragonet of our shores is *Callionymus lyra*, sometimes called the Sculpin (866, Dragonets.

female; 865, male). At the breeding season the male becomes brilliantly coloured and differs from the female in the shape of the snout and the dorsal fins.

The fishes of the family Gobiesocidæ have a protractile mouth of moderate size; the pelvic fins are widely separated from each other; the dorsal and anal fins are short and without spines; there are no scales in the skin. There is a ventral sucker, simple or double, supported by the pectoral and pelvic girdles and the pelvic fins. These fishes, known as Cling-fishes, are small, and are met with between tide-marks among loose stones and shells, to which they cling by their ventral sucker. They are of world-wide distribution; species of *Lepadogaster* occur on the British coasts, particularly the Cornish Sucker, *Lepadogaster gouanii*, 868.

Wolf-fish. The Blenniidæ have more or less elongate bodies, naked or with small scales. The dorsal and anal fins are long, and the caudal is distinct. All of the dorsal fin-rays are spinous or non-articulated, or the anterior ones only. The family is a large one, composed mostly of small marine fishes; the largest are the Wolf-fishes (*Anarrhichas*), some of which grow to five feet in length. The Common Wolf-fish is *Anarrhichas lupus*, 871, and fig. 90, in some

FIG. 90.—Wolf-fish, *Anarrhichas lupus*.

parts known as the Cat-fish or Sea-cat. The Wolf-fishes are unprepossessing, voracious animals with powerful body and strong jaws and teeth (see skull 872). The Wolf-fish has been known to attack persons wading in the water at low tide. The flesh is good, but is not much eaten. The genus *Blennius* is represented in the exhibited series by the Tompot, *Blennius gattorugine*, 873, and the Shanny, *Blennius pholis*, 874, both of which occur in British

seas. The other forms shown, *Gadopsis, Clinus, Tripterygium* and the curious looking *Patæcus*, are from the Australian region.

The fish known as the Viviparous Blenny (881–882), one of the few bony fishes that bring forth their young in an actively living state instead of depositing eggs or spawn, belongs to the family Zoarcidæ. The Zoarcidæ have very small scales or no scales in the skin; the dorsal and anal fins are long in the base and there is no distinct caudal fin; spinous fin-rays as a rule are wanting. The family is widely distributed in all seas, and some of the forms are adapted for life at great depths and have reduced eyes, to be seen only on dissection. The Cuban Cave-fish, *Lucifuga subterranea*, 880, is the only fresh-water form, and this also is blind. It is colourless and transparent, and grows to a length of five inches.

The Gunnel or Butter-fish, *Pholis gunnellus*, 879, belonging to the family Pholididæ, is a little fish common on our shores, and remarkable for the manner in which the female rolls the eggs into a ball and deposits them in a hole in the rock bored by the bivalve mollusc *Pholas*.

The Batrachidæ or Toad-fishes are a small family of fishes with a broad, flattish head and reduced gill openings. The mouth is large and the upper border is supported to a considerable extent by the maxillary bones. The spinous dorsal fin is very short, the soft dorsal, and the anal fin long in the base. The fishes of the family are sluggish and voracious, and occur near the shores of tropical and warm seas. The European Toad-fish, *Batrachus didactylus*, 878, has scales, but the American Toad-fish is without scales. The young of the former has on the ventral surface of the body a sucking disc, which soon disappears. Toad-fish.

The Ophidiidæ are fishes related to the Zoarcidæ; they have a tapering tail without a distinct caudal fin, and the pelvic fins are reduced to two pairs of filaments set just behind the chin. There are no spines to any of the fins. The example shown is *Genypterus blacodes*, 883, from Australian seas. *Aphyonus gelatinosus*, an example of one of the deep-sea members of the family, is exhibited in the series of Deep-sea Fishes (Cabinet-case 44, specimen 974).

Trachypteriformes (Ribbon-fishes).

Ribbon-fishes.

The division Trachypteriformes is a small one, containing the two families Lophotidæ and Trachypteridæ, the former with a single genus, *Lophotes*, the latter with two, *Trachypterus* and *Regalecus* (fig. 91). The body is much laterally compressed, usually ribbon-like in shape, whence the popular name "Ribbon-

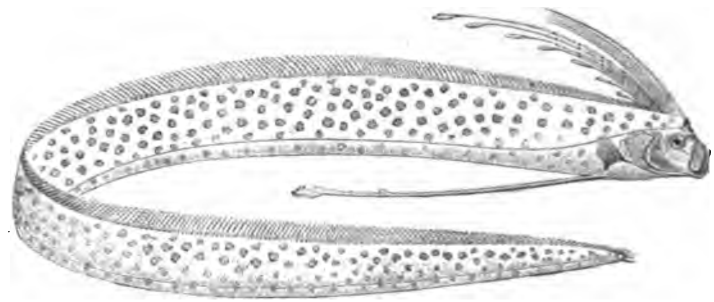

FIG. 91.—Ribbon-fish, *Regalecus gladius*.

fishes." The dorsal fin extends from the top of the head to the tail, its rays are simple and not spinous, and the anterior rays are longer than the others. The pectoral fin has a nearly horizontal base; the scales are minute or absent. These fishes occur in the deeper parts of the Atlantic, North Sea, Mediterranean, and Pacific. In the family Lophotidæ the vent is situated far back, and behind it is a short anal fin, but in the Trachypteridæ there is no anal fin and the vent is situated at about the middle of the length of the body. The mouth is very protractile in the Trachypteridæ, moderately so in the Lophotidæ.

The Deal-fish or Northern Ribbon-fish, *Trachypterus arcticus*, of which a coloured drawing (885) of the natural size is shown, has six fin-rays in the pelvic fin, and the caudal fin consists of two parts, the upper of which is large and upwardly directed. Specimens of the Deal-fish are occasionally stranded upon the coasts of Scotland and Norway. In the young *Trachypterus* (886) the fin-rays of the first dorsal and the pelvic fins are remarkably long, and the dorsal fin-rays are provided with arrow-head lappets of skin set at regular intervals. A specimen of *Trachypterus cristatus* from the Mediterranean is shown, mounted in a glass vessel of alcohol (884).

Regalecus has no caudal fin, and the pelvic fin is composed of a single fin-ray. The Oar-fish or Ribbon-fish (*Regalecus glesne*) is occasionally cast up on the coasts of Cornwall and Yorkshire, and off Bergen, in Norway. The Scandinavian fishermen call it the "Sild-Kung" or King of the Herrings, and imagine that if one is killed the Herrings will depart from the district. The coloured drawing 887 is a life size representation of the Southern Ribbon-fish, *Regalecus argenteus,* specimens of which are obtained off New Zealand and Australia. A skeleton of *Regalecus argenteus* twelve feet long is shown elsewhere in the Gallery. Some of the "Sea-serpents" seen by sailors and others may have been large specimens of the Ribbon-fish. Specimens of more than 25 feet in length are known.

Lophiiformes (Angler-fishes).

Wall-case 20.

The Lophiiformes, known also as the Pediculati, are a suborder of Teleostean fishes comprising the families Lophiidæ (Angler-fishes), Ceratiidæ, Antennariidæ, and Malthidæ (Bat-fishes). The pectoral fins are set far back and the bones of the fins are elongated; the pelvic fins are jugular in position. The head is large, the gill-opening is small and far back, and the gills are reduced in number to two or three on each side. One or more dorsal fin-rays standing upon the head are modified into tentacular structures known as "lures." The Lophiiform fishes are poor swimmers and are mostly of sluggish habits.

In the Lophiidæ (fig. 92) the mouth is very large and has teeth which are so hinged as to bend over towards the throat (see jaw 893). The skin is soft and bare. The fishes have a depressed body and live on the bottom, at moderate or great depths. The most familiar is the Angler-fish, Fishing-frog or Sea-devil, *Lophius piscatorius,* 892, in which the first few dorsal fin-rays are set over the snout and are long and flexible; they terminate in dermal expansions which are the lures. The fish "angles" with these lures, and by a sudden opening of its great mouth swallows such small fishes as nibble at them. Around the margin of the body are fringed lappets of skin which by their resemblance to sea-weed

Angler.

serve to render the body less conspicuous (fig. 92). The Angler grows to five feet in length; two specimens of about that length, and also a large skeleton, are shown elsewhere in the Gallery.

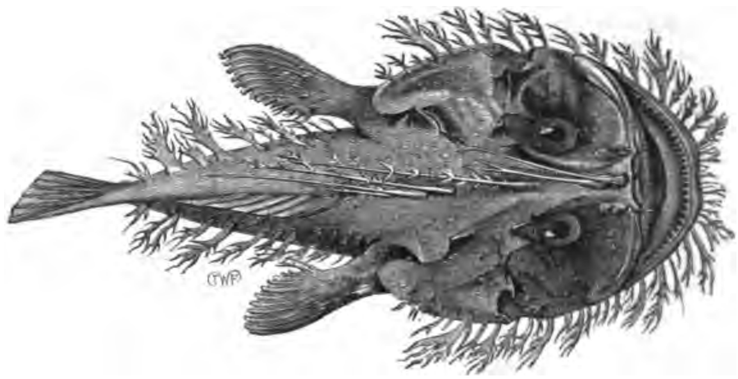

FIG. 92.—Angler or Sea-devil, *Lophius naresii*. The branched processes of skin are longer in this than in the British species, *Lophius piscatorius*.

The Ceratiidæ, represented by *Dolopichthys allector* in the series of Deep-sea Fishes (Cabinet-case 44, specimen 972), may be regarded as Angler-fishes modified in relation with a deep sea habit. The skin is bare and black in colour; the lure may be luminous; pelvic fins are absent. The bones are thin and light.

The Antennariidæ are strange-looking fishes occurring in tropical seas and rarely descending below the surface. They are sometimes called Frog-fishes because they creep along the rocks like Frogs or Toads, the pectoral fins being geniculated or bent after the manner of a knee-joint. *Chaunax pictus* (896), a reddish deep-sea fish, and *Antennarius histrio* (895) are shown. The species of *Antennarius* are numerous, and most of them occur in association with living corals, among which they lie effectively concealed by reason of the similarity between the colour of their skin and that of the coral. Some species (e. g. *Antennarius marmoratus*) occur in mid-ocean among the Gulf-weed (*Sargassum*).

In the Malthidæ the mouth is smaller than in most of the Lophiiform fishes and opens downward rather than upward. The

pectoral fin is strongly geniculated. The gill-opening is above the pectoral fin, instead of below or behind. There is no conspicuous lure; if present it is lodged in a depression below the snout and serves presumably as a tactile organ. The skin is provided with small tubercles or spines or bony warts. Most Malthid fishes are found in deep seas of the tropical regions, although the Bat-fish itself, *Malthe vespertilio*, 897, is a shallow-water form. It occurs abundantly in the West Indies. When on the ground it stands upon its pectoral and pelvic fins and resembles a Toad in general attitude. The skeleton of the Bat-fish (898) shows the remarkable elongation of the basal bones of the pectoral fins. *Halieutæa* (899) is allied to the Bat-fish, but the outline of the head is more circular, and there are also differences in the skeleton. Bat-fish.

Balistiformes (File-fishes and Sun-fishes).

The suborder Balistiformes, or Plectognathi, includes aberrant fishes, such as the File-fishes, Trunk-fishes, Globe-fishes, and Sun-fishes. The jaws are short, the maxillary and premaxillary bones are often firmly united, and the teeth may be confluent into a beak. The bones of the gill-cover are reduced and the gill-opening is small. The vertebræ are comparatively few and there are no ribs. The flesh of most of these fishes is poisonous, and if eaten produces a disease of the nervous system known as "Ciguatera."

In the first family, the Triacanthidæ, the teeth remain separate; there is a spinous dorsal fin with one large and one or more smaller spines, and the pelvic fins have each the form of a strong spine, whence the name Triacanthidæ or three-spined fishes. They are fishes of the Indian and Pacific Oceans. Two species of *Triacanthus* (900 and 902) are exhibited, also a skeleton (901). A cast of *Halimochirurgus* from the Manaar Gulf, Ceylon, is shown in the series of Deep-sea Fishes (Cabinet-case 44, specimen 977). It is a deep-sea genus of the family, remarkable for its long, tube-like snout.

The Triodontidæ have the premaxillary bones confluent with the maxillaries, and the teeth are fused to form a beak. The upper

beak is divided by a median suture, whereas the lower is undivided, whence the name Triodont or three-toothed fishes. There is no spinous dorsal fin, and there are no pelvic fins. The abdomen has a dilatable sac. The body is covered with small spiny laminæ of bone. There is a single species, *Triodon bursarius*, 903, of the Indian Ocean.

File-fish. In the File-fishes (family Balistidæ) the teeth remain separate and have the form of incisors. There is a spinous dorsal fin; the pelvic fins are absent, or they take the form of a single short spine

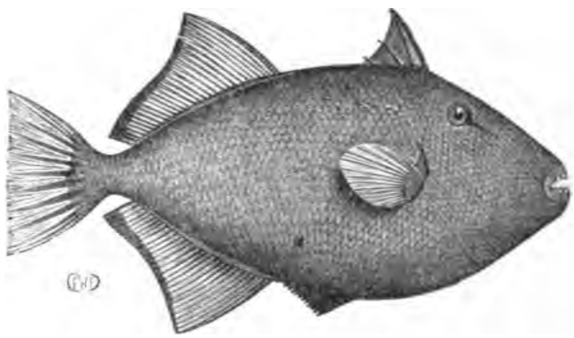

FIG. 93.—File-fish, *Balistes vidua*.

at the end of the long pelvis (see skeleton 912). The principal genera are *Balistes* (File-fishes or Trigger-fishes, fig. 93), *Monacanthus* and *Aluteres*. They are all inhabitants of tropical and temperate seas. The largest species of the genus *Balistes* grow to three feet. The body is protected by closely-fitting, hard, rhomboidal scales. The teeth are powerful and enable the animal to break off pieces of coral, etc., on which it feeds, and to bore into or chip the edges of shells of molluscs; the Pearl Oyster is particularly liable to attack (see the shells 920). One species of *Balistes* (*B. capriscus*, 911) is occasionally caught in British seas; the exhibited specimen was obtained on the Cornish coast. Eleven other species of *Balistes* are exhibited (907–910 and 913–919) which serve to show the wide range of colouring and marking observable in the genus. *Erythrodon* (921) is a subgenus of *Balistes* distinguished by the possession of red teeth. *Monacanthus*

does not have large bony plates in the skin, but very small scales or spines of uniform size; five species are represented, also a skeleton (922–927).

The Ostraciontidæ, commonly called Trunk-fishes or Coffer-fishes (fig. 94), are tropical fishes living near the bottom in shallow water. The body is encased in a carapace formed of large bony plates, mostly hexagonal in shape. There is no spinous dorsal fin, and the pelvic fins are wanting. The chief genera are *Ostracion* and *Aracana*. Some species of the former have strong, sharp spines (e. g. *Ostracion cornutus*, 932), a pair pointing forward in front of the eyes and a pair pointing backward beneath the tail. Trunk-fish.

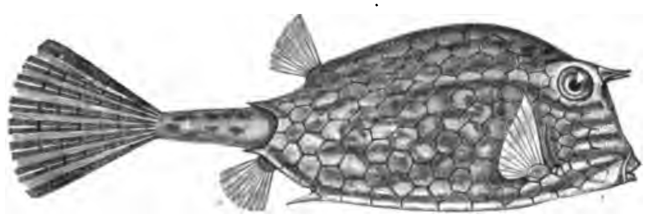

FIG. 94.—Coffer-fish, *Ostracion quadricornis*.

Six species of *Ostracion* are shown (929–934). *Aracana* differs from *Ostracion* in that the bony carapace is not closed behind the anal fin; three species are shown (935–937).

In the Tetrodontidæ the teeth are coalescent, forming upper and lower beaks. The beaks are divided by a median suture, so that there appear to be four large teeth, whence the name 'Tetrodont' (see skull 942). The skin is either smooth or with movable spines, rarely with bony plates. There is no spinous dorsal fin, and pelvic fins are wanting. The Tetrodont fishes can inflate their belly with air, whence they are commonly termed 'Puffers' or 'Globe-fishes.' When thus inflated they float helplessly at the surface of the water, belly upwards. The Tetrodont fishes occur in all tropical and warm seas; a few species are found in fresh water. Thirteen species of *Tetrodon* are shown (941, 943–947, 949–955) and a skeleton of *Tetrodon stellatus* (948). Globe-fish.

In the Diodontidæ, as in the preceding family, the teeth are coalescent, forming beaks. The upper and lower beaks have no Porcupine-fish.

median suture, however, and appear as two great teeth, whence the name 'Diodont' (see jaws 956). There is no spinous dorsal fin, nor pelvic fins. The body is inflatable (fig. 95) ; there are movable bony spines in the skin, and in the long-spined species the spines stand out from the skin when the belly is inflated with air, although otherwise they slope backward. This capacity of erection of the spines has gained for the Diodont fishes the name of

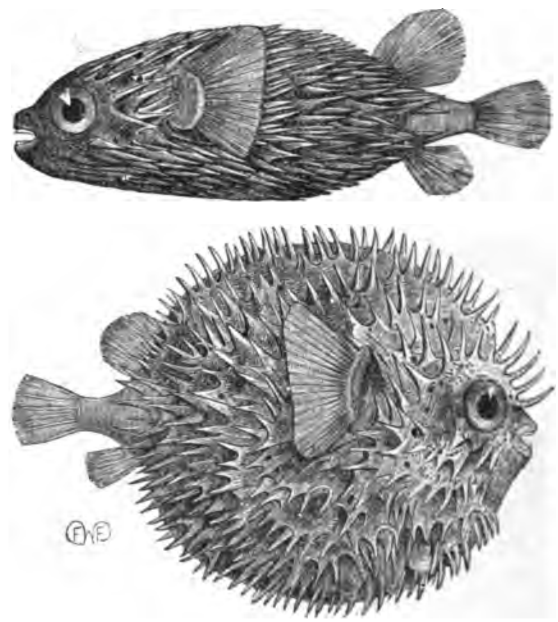

FIG. 95.—Porcupine-fish, *Diodon maculatus*; as swimming and when inflated.

'Porcupine-fishes.' Two specimens of the common Porcupine-fish, *Diodon hystrix*, are shown (958–959). the upper specimen in a state of inflation, the lower in the condition in which the fish swims about. Several other species are shown (961–966). The Diodontidæ are confined to tropical seas.

Sun-fish. In the Sun-fishes (family Molidæ) the teeth are coalescent, forming beaks ; these have no median suture. The swim-bladder is absent and the body is non-inflatable. The body is short and

has high dorsal and anal fins. There is no true tail, but the dorsal and anal fins are confluent around the truncated hind end of the body. There is no spinous dorsal fin, and pelvic fins are wanting. The Sun-fishes are of wide distribution, and grow to a great size. A large specimen of the Rough Sun-fish, *Orthagoriscus mola*, obtained from Australia, hangs from the middle of the roof at the northern end of the Gallery. A somewhat smaller specimen, caught off Dungeness, hangs from the rail opposite Wall-case 8. The small specimen (967) shown in Wall-case 20 was also caught on the English coast. The Sun-fish is of particular interest, because, although recently the young larvæ or Leptocephali of the Common Eel have been caught by nets in the Atlantic Ocean, our earlier knowledge of them was based mainly upon specimens found in the stomachs of Sun-fishes caught on the Italian coast. The

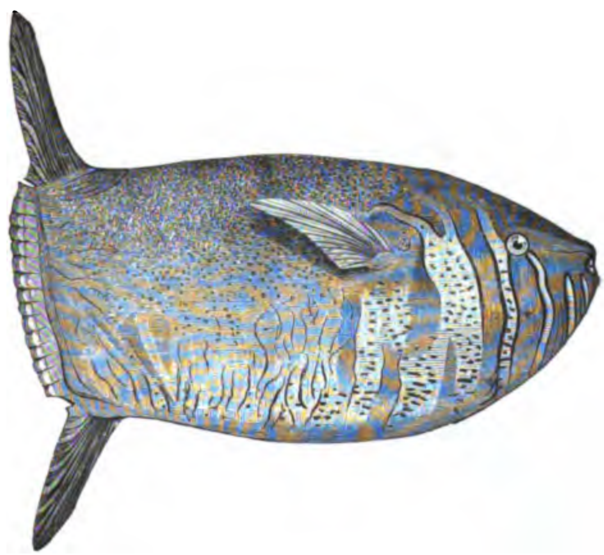

FIG. 96.—Oblong Sun-fish, *Ranzania truncata*.

Oblong Sun-fish, *Ranzania truncata*, 968 (see fig. 96, and compare with fig. 3, p. 11), differs from the Rough Sun-fish not only in shape, but in possessing a smooth skin with hexagonal plates, whereas the Rough Sun-fish has a rough, minutely granulated skin.

Classification of Fishes adopted in the Fish Gallery.

CLASS PISCES.

Subclass I. **ELASMOBRANCHII.**

Order 1. PROSELACHII.

Order 2. ACANTHODIDES.

Order 3. SELACHII.

Suborder 1. NOTIDANI.
Suborder 2. SQUALI.
Suborder 3. RAII.

Order 4. PLEURACANTHODES (= ICHTHYOTOMI).

Subclass II. **HOLOCEPHALI.**

Subclass III. **OSTRACODERMI.**

Order 1. HETEROSTRACI.

Order 2. OSTEOSTRACI.

Order 3. PTERICHTHYOMORPHI (= ANTIARCHA).

Subclass IV. **DIPNOI.**

Order 1. CTENODIPTERINI.

Order 2. MONOPNEUMONES.

Order 3. DIPNEUMONES.

Order 4. COCCOSTEOMORPHI (= ARTHRODIRA).

Subclass V. **TELEOSTOMI.**

These are often spoken of as "Ganoid Fishes,":

Order 1. STYLOPTERYGII (= CROSSOPTERYGII, auct.).

Suborder 1. TARRASIOIDES (= HAPLISTIA).
Suborder 2. HOLOPTYCHIOIDES (= RHIPIDISTIA).
Suborder 3. CŒLACANTHOIDES (= ACTINISTIA).
Suborder 4. POLYPTEROIDES (= CLADISTIA).

Order 2. ASTYLOPTERYGII.

Suborder 1. STURIONIFORMES (= CHONDROSTEI).
Suborder 2. AMIIFORMES (= PROTOSPONDYLI).
Suborder 3. LEPIDOSTEIFORMES (= ÆTHEOSPONDYLI).

Order 3. NEICHTHYES (= TELEOSTEI).

Grade A. **Physostomi.**

Suborder 1. SALMONI-CLUPEIFORMES (= ISOSPONDYLI).
Suborder 2. CYPRINI-SILURIFORMES (= OSTARIOPHYSI).
Suborder 3. SYMBRANCHIFORMES.
Suborder 4. ANGUILLIFORMES (= APODES).
Suborder 5. ESOCIFORMES (= HAPLOMI).

Grade B. **Physoclisti.**

Suborder 6. HALOSAURIFORMES (= HETEROMI).
Suborder 7. GASTROSTEIFORMES (= CATOSTEOMI).
Division 1. *Selenichthyes.*
Division 2. *Hemibranchii.*
Division 3. *Lophobranchii.*
Division 4. *Hypostomides.*

Suborder 8. MUGILIFORMES (= PERCESOCES).

Suborder 9. GADIFORMES (= ANACANTHINI, in part).

Suborder 10. ACANTHOPTERYGII.

Division 1. *Perciformes.*
Division 2. *Scombriformes.*
Division 3. *Zeorhombiformes.*
Division 4. *Kurtiformes.*
Division 5. *Gobiiformes.*
Division 6. *Echeneiformes* (= *Discocephali*).
Division 7. *Trigliformes* (= *Scleroparei*).
Division 8. *Blenniiformes* (= *Jugulares*).
Division 9. *Trachypteriformes* (= *Tæniosomi*).
Division 10. *Mastacembeliformes* (= *Opisthomi*).

Suborder 11. LOPHIIFORMES (= PEDICULATI).

Suborder 12. BALISTIFORMES (= PLECTOGNATHI).

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